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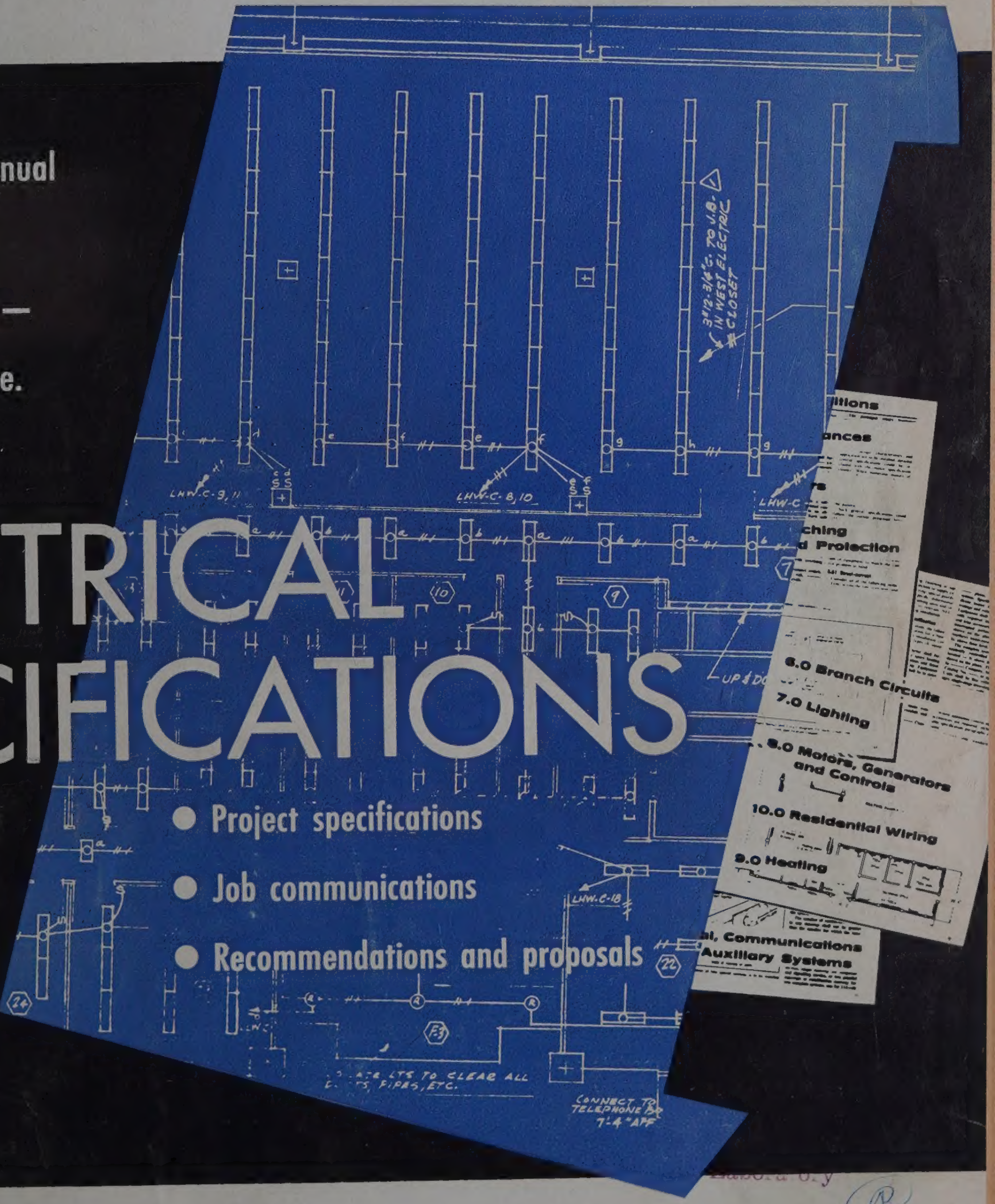

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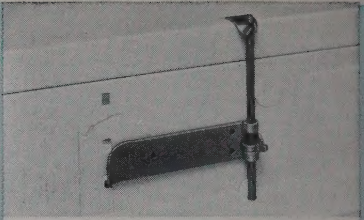

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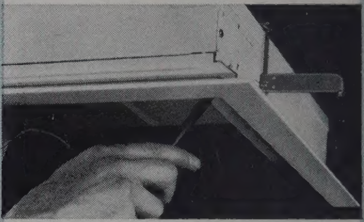

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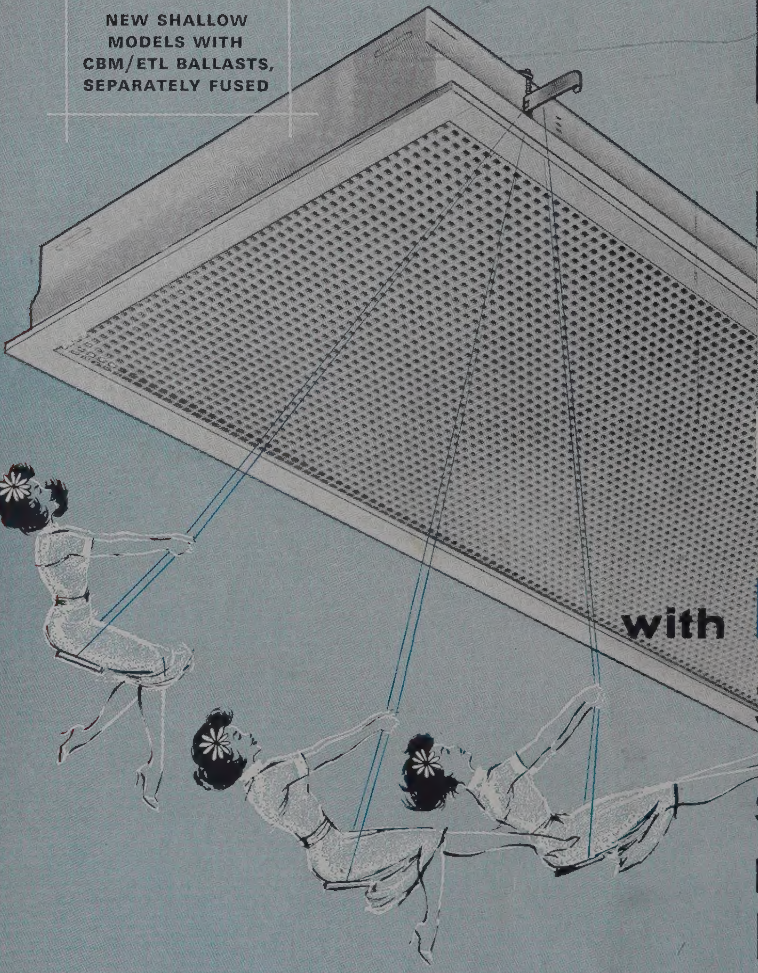

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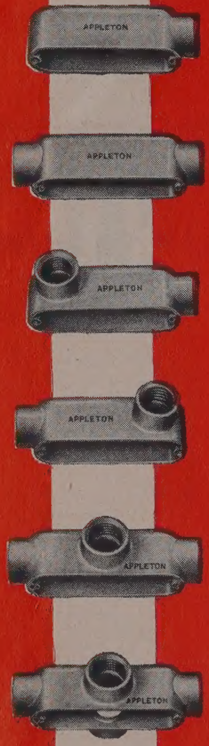

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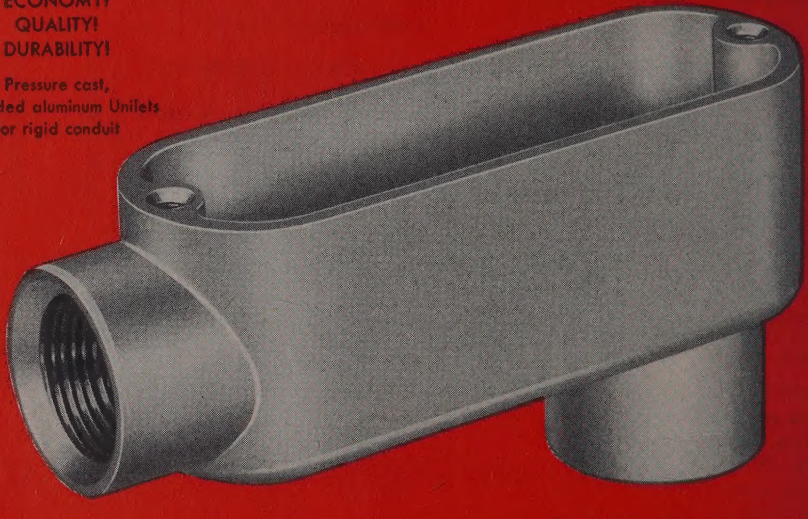

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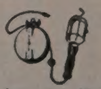

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Vol. 60, No. 5 May 1961
ELECTRICAL CONSTRUCTION
and MAINTENANCE

Published monthly with an additional issue in September by McGraw-Hill Publishing Company, Inc. James H. McGraw (1860-1948), Founder. Executive, Editorial, Circulation and Advertising Offices: **McGraw-Hill Building, 330 W. 42nd St., New York 36, N.Y.** Printed in Albany, N.Y. **Officers of the Publications Division:** Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. **Officers of the Corporation:** Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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United States subscription rate for individuals in the field of the publication $3.00 per year. This issue $2.00. Electrical Products Guide $2.50. Canada $5.00 a year. All other countries, $15.00 a year, payable in advance. Second class postage paid at Albany, N.Y., and at additional mailing offices. Printed in U.S.A. Title registered in U.S. Patent Office. © Copyrighted 1961 by McGraw-Hill Publishing Co., Inc. — All Rights Reserved.

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with which is consolidated Electrical Contracting, The Electragist and Electrical Record . . . Established 1901

Published for electrical contractors, electrical departments in industry, engineers, consultants, inspectors and motor shops. Covering engineering, installation, repair, maintenance and management in the field of electrical construction and maintenance.

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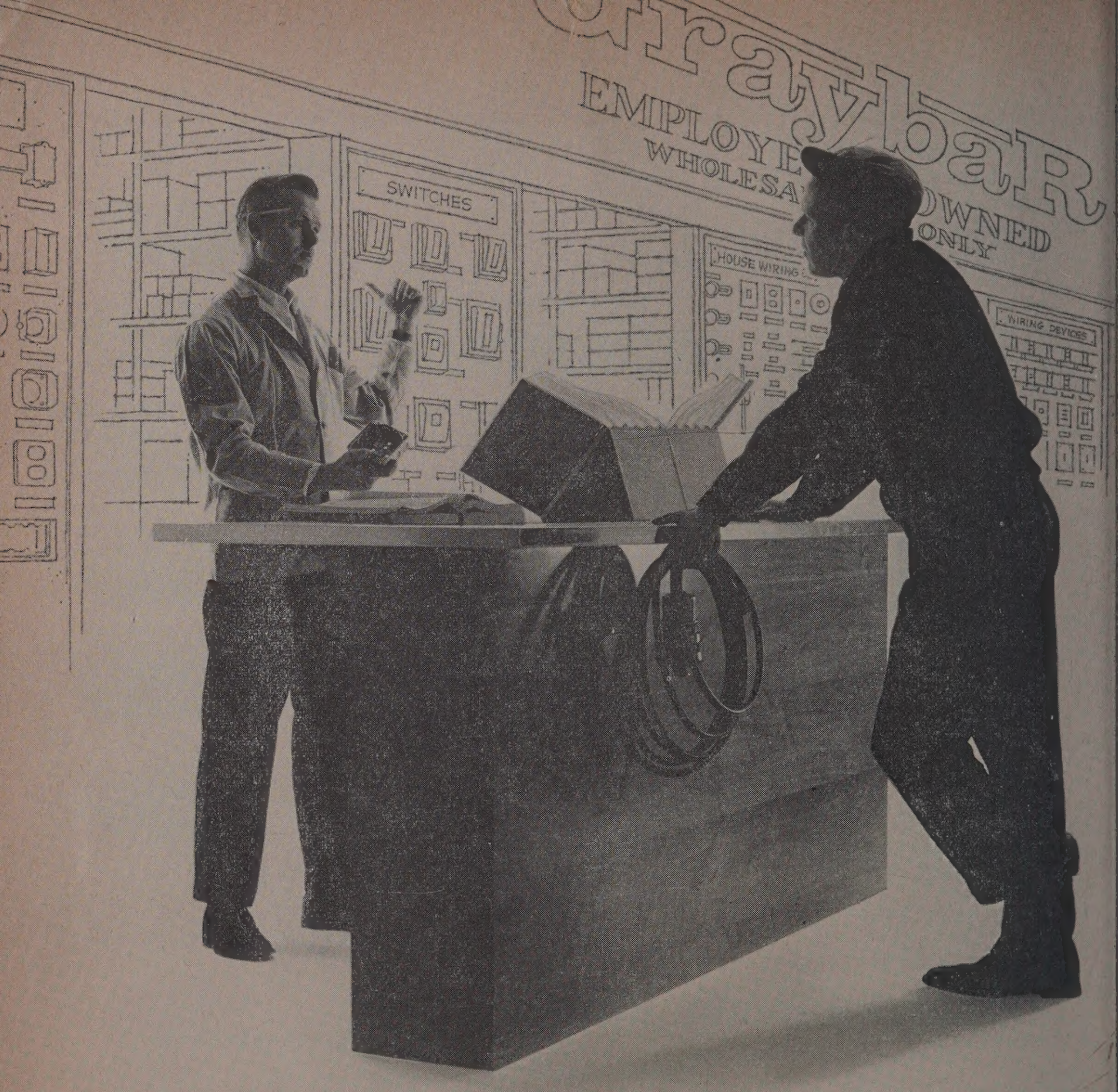

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Sidelights

ELECTRICAL SPECIFICATIONS

The major part of the editorial contents of this issue is devoted to a comprehensive master electrical specification. Much new material has been added and many items have been revised and brought up-to-date since the last revision in May 1958. The project has also had the benefit of many constructive comments and suggestions from our readers. Reprints will be available about June 1 at $1.50 each.

GAS ENERGY SYSTEMS

New all-gas energy systems for buildings discussed in our editorial last month will be described with details of a current installation in a Little Rock, Ark., shopping center in the lead feature article of our June issue. Such gas energy systems include on-site electrical power generation by means of gas turbine driven generators. The exhaust gases fuel steam systems for other services. The new system is being incorporated into several projects now under construction in the Texas area.

ELECTRIC CONTROLS

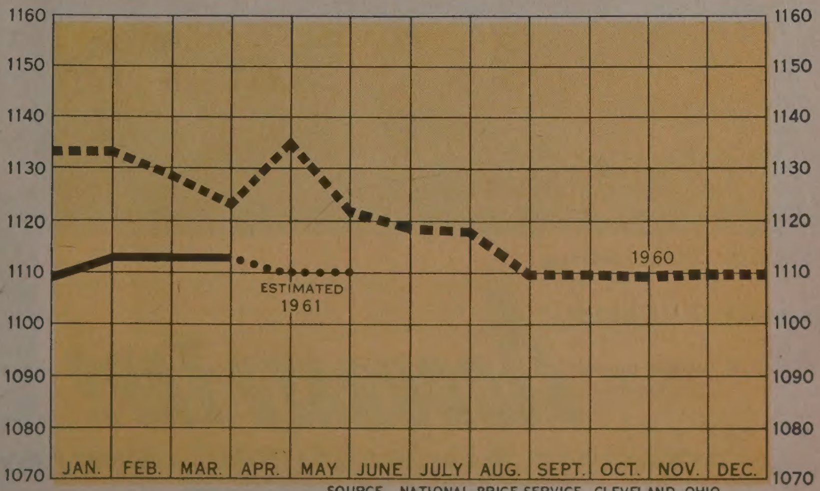
In May 1957, *Electrical Construction & Maintenance* published a special 50-page editorial report on "Electric Controls." It was an exclusive and original project prepared by Associate Editor J. F. McPartland and enjoyed a highly favorable response from our readers. Requests for reprints ran into the many thousands. Interest in the project and the subject has persisted so remarkably that plans have been made for a new and extensively revised edition. This new and basic report will be of prime interest to everyone concerned with the selection, application, installation or maintenance of electric control apparatus. Watch for it in the July issue.

RESIDENTIAL WIRING

Prospects for residential wiring activity are looking better with the Spring upturn in home building. Lower interest rates and more available mortgage money is also expected to stimulate this part of the construction market which has been sagging badly since last year. Important, too, for electrical contractors is the opportunity to build residential installations to higher standards of value and utility. "Profit Aids for Residential Electrical Systems" from our March issue is a useful guide now available as a reprint at 50 cents per copy.

ELECTRICAL MATERIALS COST INDEX

BASE LINE (1000) REPRESENTS COSTS OF TYPICAL ASSORTMENT OF MATERIALS FOR A SELECTED JOB AS OF NOVEMBER 1, 1951. INDEX POINTS REPRESENT THE VARIATION OF THESE SAME MATERIAL COSTS AS OF THE FIRST OF EACH MONTH.



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Washington Report

MAY • 1961

Business activity turned upward with the coming of spring, leaving behind one of the most discussed, and probably one of the mildest "recessions" of the postwar period.

Gross National Product, the broadest indicator of the national economy, declined less than 1.5% from its peak of $505 billion reached in last year's 2nd quarter. GNP in 1961's first quarter was $499.5 billion, down less than 1% from last year's 4th quarter rate of $503.5 billion. Current forecasts are: 2nd (current) quarter—$505 billion; 4th quarter—$519-520 billion; GNP average for 1961—$509 billion.

Other favorable economic indicators:

- **Industrial production** turned up in March for the first time in eight months, to FRB Index of 102.4 (of 1957 average). Record is 111, reached in January 1960, and recession low of 102.0% was set in January and February of this year.

- **Personal income** turned up in March, to $407.8 billion, halting its five-month slide.

- **Orders and sales** of durable goods rose in March for the second consecutive month.

- **Housing starts** jumped from 77,900 in February to 106,500 in March for more-than-usual increase.

- **Steel production** exceeded 1.7 million tons per week in April for the first time since June 1960.

- **New construction spending rose seasonally** in March to $3.87 billion, compared with $3.59 billion in February. Total construction outlays for first quarter were $11.3 billion, approximately the same as for first quarter of 1960. Actual private expenditures for new construction in March were $2,756 million, while public expenditures totaled $1,115 million.

The Post Office Department's $270 million construction program, formerly scheduled for an 18-month period, was stepped up in March, under executive order, to a 10-month period. About $100 million of this construction will be made with federal funds, and about $169 million with private funds under lease commitments from the Post Office Department.

Highway construction contracts, now totaling $928 million, are running 36% ahead of last year, and more contracts are already in the making.

Industrial construction contracts are also running about 40% ahead of the same period of 1960, and new contracts are being let as fast as they come off the drawing boards.

Retail sales in March turned upward to a seasonally adjusted annual rate of $18.1 billion, nearly equal to the March 1960 sales of $18.2 billion annual rate, but still shy of the record high of $18.9 billion annual rate for April 1960. Sharing in the increases were textiles, durable goods, autos, and appliances and furniture.

Consumers reduced installment credit in February for the second straight month, with repayments exceeding new credits by $518 million. Total repayments exceeded $1.9 billion.

Employment and unemployment both touched record highs in March. There were 65.5 million employed, and 5.5 million unemployed, with the adjusted rate of unemployed to total labor force totaling 6.9%. Unemployment should not exceed 4% of the labor force, according to Administration spokesmen.

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LET'S KEEP

Business Help For Our Colleges Going Full Speed Ahead

"Should our company fold up its program of financial help for higher education now that the Kennedy Administration plans to have the federal government provide this kind of help in a big way?" It is clear why, in the light of campaign promises and plans announced since, this question is being raised in many business firms at this juncture.

What seems far clearer, however, is the right answer to the question. It is a resounding NO! **This is no time for the business community to ease up in what have been its notably successful efforts to help our colleges and universities get out of the deep financial hole in which they are operating. On the contrary, this is the time to put more steam than ever behind the drive of business to increase its financial help for higher education.**

Massive Help Needed

It is easy to understand why any individual businessman or firm might have a rather despairing feeling about the prospect of competing with the federal government, with its almost all-embracing tax arm, in providing financial support for higher education or almost anything else for that matter. But this is not a case of competition. It is a case where our colleges and universities must have massive help all along the line if they are to be put squarely back on their feet financially—a goal of crucial and perhaps decisive national importance. **The business community will continue to have both the opportunity and the obligation to keep on increasing its help for higher education as rapidly as possible.**

To underline this proposition take a look at the chart at the top of the next page. It shows how far the salaries of college and university faculty members continue to lag behind those of other occupational groups in the U.S.A. There has been some relative improvement in the average of faculty salaries in recent years. And the salary improvement in some fields, such as those of science and mathematics, has been very pronounced. But the chart makes clear how badly the average salary of college and university faculty members still lags.

No Federal Funds For Salaries

The plans for increased financial aid for higher education, proposed by President Kennedy, do not contemplate increased expenditure for faculty salaries. This, we believe, is wise whether or not you feel, as many do, that resort to this kind of federal financing would inevitably carry with it federal controls that would ultimately undermine academic independence. The fight over federal appropriations for faculty salaries would be so long and bitter that it would be destructive to the aid program as a whole.

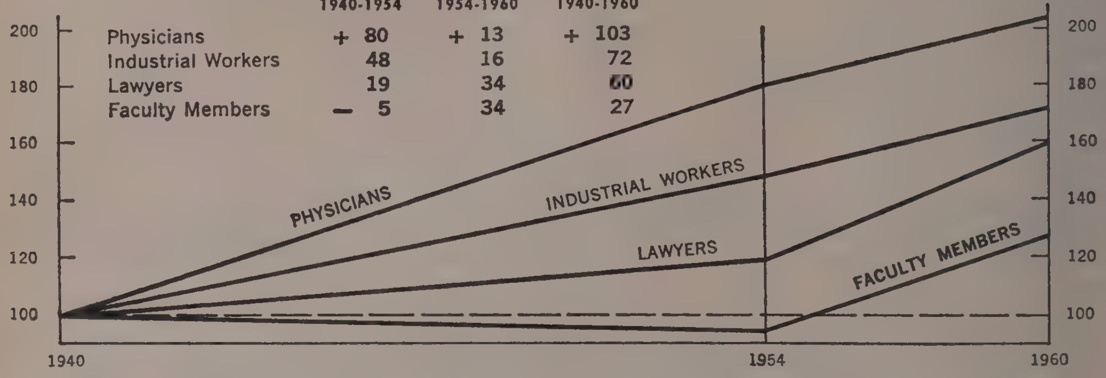
However, what the federal government will not be doing to remedy the deplorable condition of faculty salaries, as reported by the chart, is one indication of the tremendous scope that remains for crucially important help for higher education from business. Manifold other indications are available.

Disaster Escape Route

One of these indications is provided by the careful calculation that the annual income of our colleges and universities must be increased by about $4½ billion (from about $4½ billion to about $9 billion) over the next eight years if the tremendous wave of students

WHAT HAS HAPPENED TO COLLEGE FACULTY SALARIES

Index (1940=100)



Percent Change
Real Income Before Taxes

	1940-1954	1954-1960	1940-1960
Physicians	+ 80	+ 13	+ 103
Industrial Workers	48	16	72
Lawyers	19	34	60
Faculty Members	— 5	34	27

Sources: U.S. Department of Commerce; U.S. Department of Labor; National Education Association: McGraw-Hill Dept. of Economics.

now gathering to descend on these institutions is not to wind up in both a financial and an educational disaster. This wave promises to add more than 2.5 million, or 75%, to college enrollments by 1970.

Thus far, the program for financial help for higher education by business, spearheaded by the Council for Financial Aid to Education, has been a remarkable success in all dimensions. The dollars contributed have increased rapidly—from about $100 million five years ago to about $150 million this year. Contributions of $500 million a year by 1970 are a clear possibility.

One of the inspiring developments increasing this possibility stems out of Cleveland, Ohio. There through their chief executives, an imposing group of business firms have established one per cent of their profits before taxes as their minimum goal for contributions to higher education, to be reached within three years. General acceptance of this goal by business would go most of the way toward getting our colleges and universities firmly on their feet financially.

Mutual Respect Increased

The mutual esteem of the academic community and the business community, an element of enormous importance to a free society, has been increased by the manner in which the program of financial aid has been carried out. In making its contribution, there has been no attempt whatsoever on the part of business to encroach upon the academic freedom of the institutions financially benefited. And the program of financial aid has greatly increased the knowledge, understanding and respect which the colleges and universities and business have for each other.

The Kennedy Administration's program to enlarge federal financial support of higher education is certain to arouse strenuous controversy. As proposed by its Task Force, it avoids some of the most controverial areas of principle. However, the very magnitude of the proposed extension of the federal government's already vast program of financing higher education involves fighting issues.

But if the enlargement of federal aid were to be deeply discouraging to the continued expansion of private aid for higher education, it would be a national misfortune of major proportions. There is no good reason why it should be. On the contrary, there is compelling reason for the business community to continue giving higher education all the financial help it possibly can, thus speeding onward a program that has been and continues to be a major constructive force for our colleges and universities, for business and for the nation.

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald C McGraw
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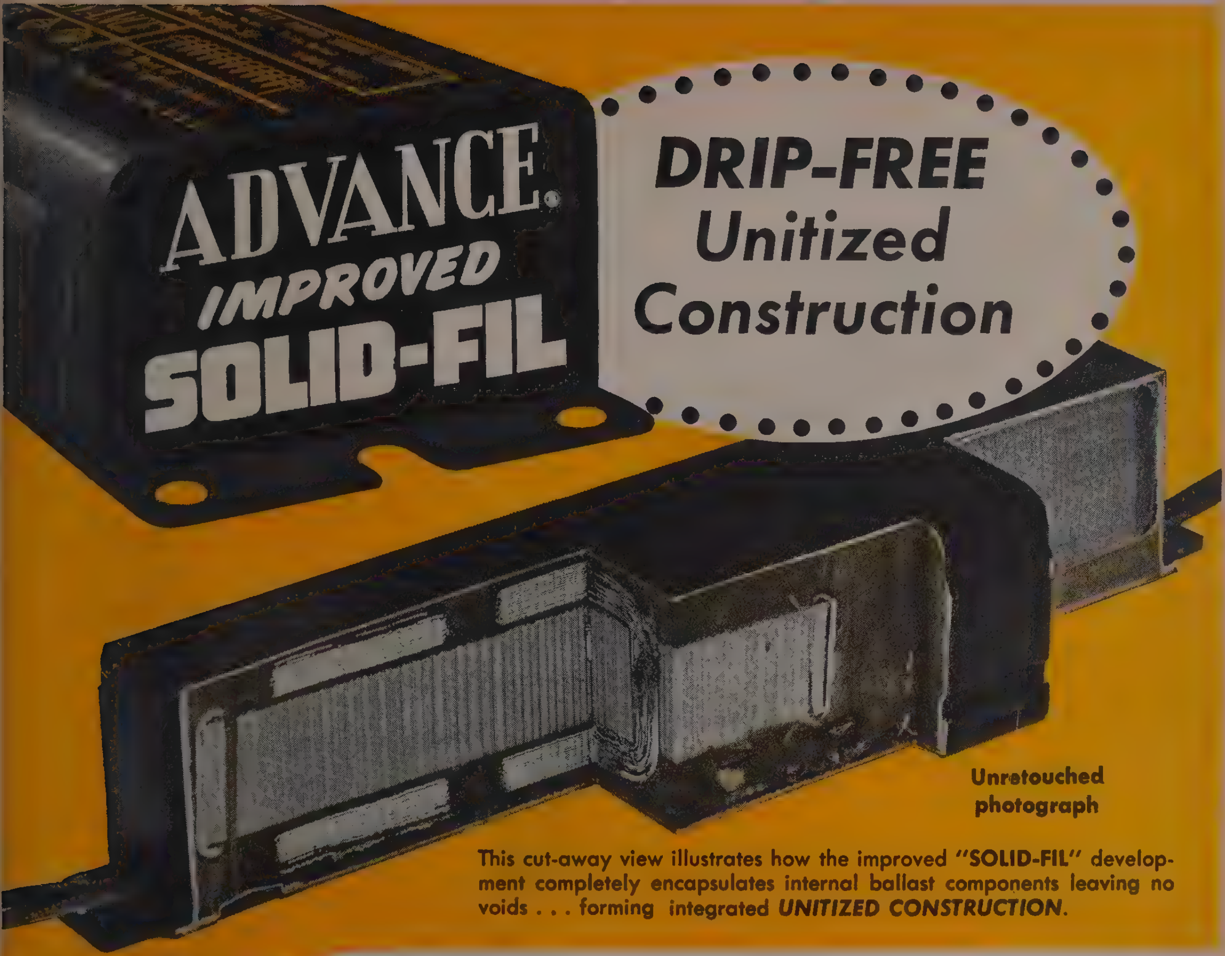

DRIP-FREE Unitized Construction

Unretouched photograph

This cut-away view illustrates how the improved **"SOLID-FIL"** development completely encapsulates internal ballast components leaving no voids . . . forming integrated ***UNITIZED CONSTRUCTION***.

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Allen C. Edwards is a complete home-building service owning many of its own subassembly and building supply operations. It is currently completing a 110-home operation in Sunset Heights, six miles west of Portland. Concealed wiring is going into these homes.

"I think it's a definite sales feature," says Mr. Sorensen. "I'm sold on it. It's worth promoting!"

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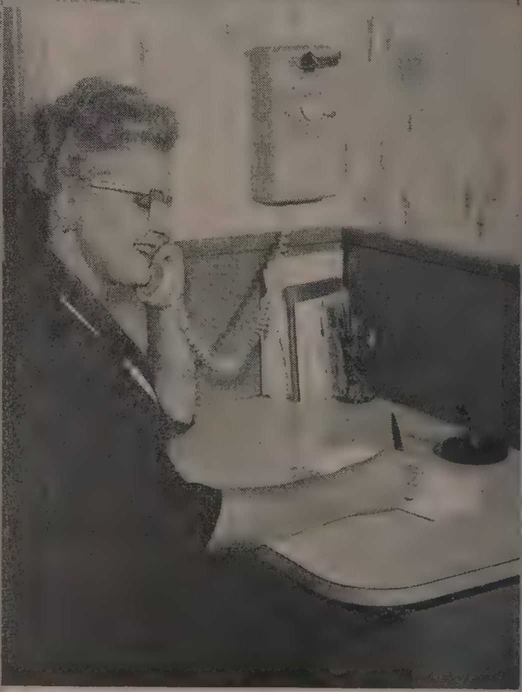
Allen C. Edwards



ABOVE: Homeowner finds dinette wall phone convenient.

"One of the chief complaints of home buyers," says Sales Manager Ron Sorensen, "is that builders show no consideration for an owner's needs. Telephone planning is consideration, and we plan for extensions in every important area of the house."

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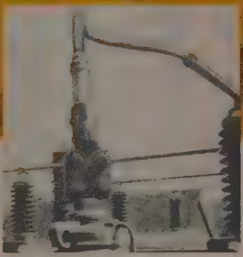
moves into HIGH POWER CONNECTIONS

Lug tap off strain bus cable



Tubing to cable flexible joint

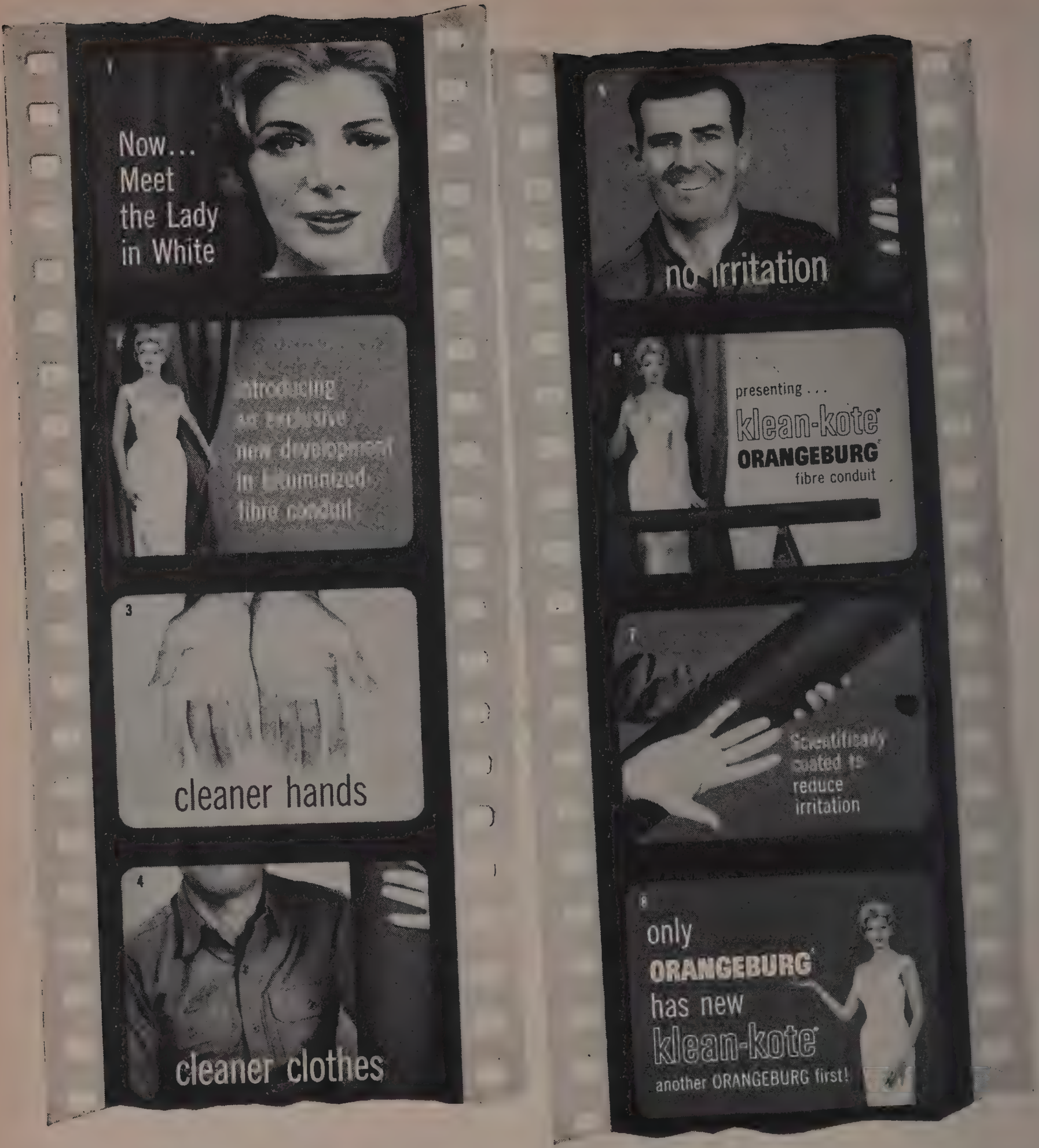
Utilities all across the country are utilizing CADWELD copper connections for their tubular bus and overhead strain bus cable. CADWELD having proved itself under the most severe current surge and corrosive conditions in copper and steel grounding systems, is now performing with the same economy and superior quality on overhead power connections.

Illustrated are standard connections of tube to: tube, lug (bus bar) and cable. Also shown in the main photo are CADWELD connections of tube to flexible, laminated, copper jumpers.

For further information contact your local CADWELD Distributor or write to: BUS TUBE % ERICO PRODUCTS, INC.

CADWELD® electrical connections

Erico Products, Inc.
2070 E. 61st Place • Cleveland 3, Ohio
IN CANADA: ERICO INCORPORATED, 7 Superior Ave., Toronto 14, Ontario, Canada



A development of Orangeburg and Flintkote Research, new *klean-kote* Orangeburg Brand Fibre Conduit has a tough non-brittle protective coating for cleaner, safer handling. Ask your wholesaler to show you a length. klean-kote* **ORANGEBURG® BRAND**
Fibre Conduit

FLINTKOTE® Orangeburg Manufacturing Co., Orangeburg, N.Y. Division of The Flintkote Company, Manufacturer of America's Broadest Line of Building Products

*KLEAN-KOTE IS A TRADE-MARK; U.S. PATENT APPLIED FOR.
ORANGEBURG KLEAN-KOTE IS DISTRIBUTED BY GRAYBAR ELECTRIC CO. AND GENERAL ELECTRIC SUPPLY CO. WITH BRANCHES AND STOCKS IN PRINCIPAL CITIES.

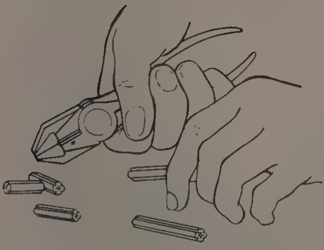
CUT YOUR ANCHORING COSTS . . . SWITCH TO

Hi FASTENERS

TRADE MARK REG.

A SIZE AND TYPE FOR EVERY ANCHORING JOB!

"Hi-RED"®
PLASTIC
SCREW ANCHORS



"Hi-RED" anchors may be cut as needed for short screws

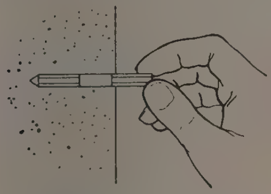
ONLY 5¢ PER MOUNTING*

(DRILL, ANCHOR AND SCREW)

*K-6 KIT

TERRIFIC HOLDING POWER

(P.T.L. ratings up to 4,180 lbs.)



. . . and used in tandem with long screws

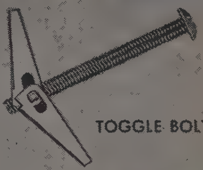
HOLD...HOLD...HOLD where others fail!

All-purpose screw anchors for use anywhere (outdoors or indoors) — in concrete, brick, stone, mortar, cinder block, tile, etc.

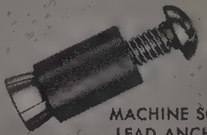
Vibration proof . . . takes smaller hole . . . no tamping! Nine sizes up to ½" lag screw. Size marked on every anchor.

CUT COSTS UP TO 70% . . . MILLIONS IN USE!

(A REAL JOB-PROVEN ANCHOR)

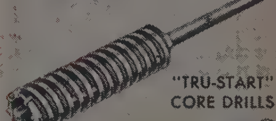


TOGGLE BOLTS



MACHINE SCREW LEAD ANCHORS

LAG SCREW SHIELDS



"TRU-START" CORE DRILLS

PERCUSSION DRILLS

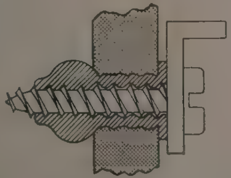
CARBIDE TIPPED MASONRY DRILLS

Hi *Wally*® PLASTIC SCREW ANCHOR

FOR HOLLOW WALLS—plaster, plasterboard, tile, etc. Holds permanently. One size wally—fits in ¼" hole. Handles screw sizes no. 6 thru no. 10.

EASY to use . . . LOW in cost!

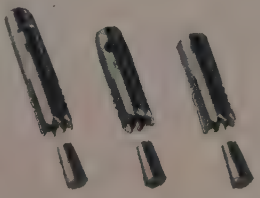
Only non-metallic anchor with "toggle bolt" action.



Hi SELF-DRILLING ANCHORS

For fast, low cost anchoring into any masonry material. Drills its own hole—no masonry drill required. Stronger than the concrete!

3 NEW IMPROVED TYPES:



SNAP-OFF TIE-WIRE FLUSH

FREE SAMPLES

DEPT. 442

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PENNSYLVANIA INTRODUCES THE

Loadmaster.*

100

...to Give You Full Circuit Protection at Less Cost

*Patents applied for

600-volt fused interrupter switch

The new Loadmaster 100*—another first from Pennsylvania—is a 600-volt load interrupter *specifically designed* to employ new current-limiting fuses in drawout switchgear. It combines the economy of a fused interrupter switch with the basic functions of a circuit breaker.

The Loadmaster 100:

Provides full overload protection with new Buss Low-Peak dual-element fuses

Provides complete major fault protection with current-limiting action within one-half cycle

Provides protection against single-phasing

Provides fully-rated systems at the price of cascaded systems

Extends economically the range of substation capacities . . . all this at a considerable savings in equipment cost—the exact amount of savings depending upon the particular application.

Complete Primary and Feeder Coordination

Overload and fault protection with the Low-Peak fuses will coordinate both with primary fuse protection and individual load controls (see fuse coordination curves). In the overload region the Loadmaster has adequate time delay, while under fault conditions the circuit is cleared well before peak current conditions are reached. A fault in any phase clears all three phases simultaneously, preventing single-phase operation.

Provides Fully-Rated System at No Increase in Cost

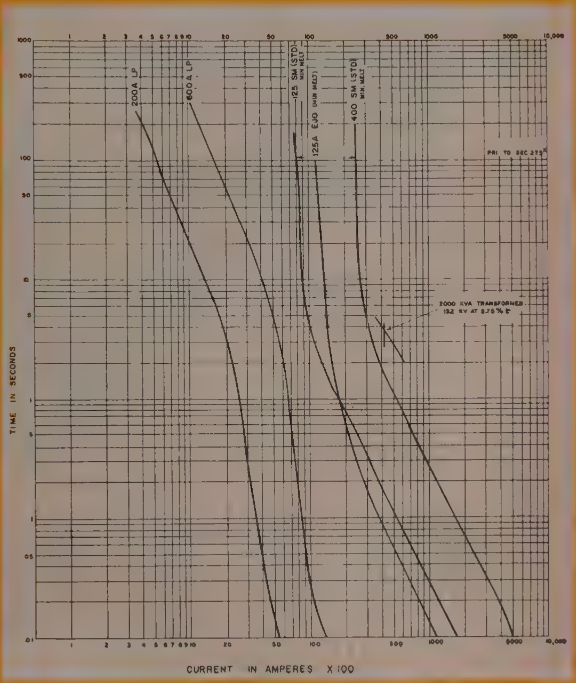
The Loadmaster 100 has an interrupting and close-in rating of 100,000 symmetrical amperes, confirmed by extensive tests at the Bussmann-Thos. A. Edison short-circuit laboratory. This rating makes it possible to provide the advantages of a fully-rated feeder system with the Loadmaster, at the cost of cascading.

More Kva per Dollar

Larger substation ratings—at less dollar cost per kva—are possible with the new Loadmaster 100. Transformer cost per kva becomes less as the rating increases. Since the standard Loadmaster 100 can replace the large-frame circuit breakers required in systems capable of delivering up to 100,000 amperes, the often prohibitive switchgear cost involved in large substations is eliminated.

Other outstanding features of Loadmaster 100:

- Electrically-operated spring-charged close and trip
- Remote close and trip control
- Blade-type contacts which eliminate bounce
- No live parts on switch front—integrally-mounted fuses requires complete disconnecting from energized bus before inspection and replacement



Overload and fault coordination provided by the Loadmaster 100 are shown by the time-current values for 200-ampere and 600-ampere Low-Peak fuses (left). Low-voltage fuses are readily coordinated with transformer primary protective devices (right).

Side view of the Loadmaster 100 shows blade-type contacts. Phase barriers and arc chute at right have been removed.

Pennsylvania Unit Substations

PENNSYLVANIA TRANSFORMER DIVISION

McGRAW-EDISON COMPANY · CANONSBURG, PENNSYLVANIA

A year ago a new type of fixture was born...*Corona,* the first fluorescent fixture to be designed as decorative element. Framed in polished walnut, it's manufactured with all the care that goes into makin a fine piece of furniture. Understandably, it's expensive ... with a much better than average profit for th electrical contractor. But cost hasn't kept it from being one of the best sellers introduced in 1960 . . . b

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Corona and Coronet are stocked by these Authorized LIGHTOLIER Distributors:

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Marle Co.
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Starbuck Sprague Co.
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WITH

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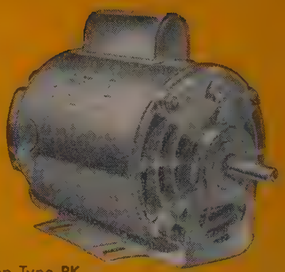
QUALITY MOTORS

Boost the productivity of the equipment you design by providing motor drives that will operate dependably, with a minimum of down time for maintenance. Choose a motor that is matched to the job, with the proper speed . . . horsepower . . . voltage—that has the right enclosure for your application . . . drip-proof . . . totally-enclosed . . . explosion-proof.

Chances are, you can find the exact motor you need in the complete line of Wagner standard motors . . . a well-known, completely dependable motor with a reputation for quality. A few of the many motors in the Wagner line are shown here. Their excellent performance in their specific applications, their price and prompt delivery make them a sound choice for your equipment.

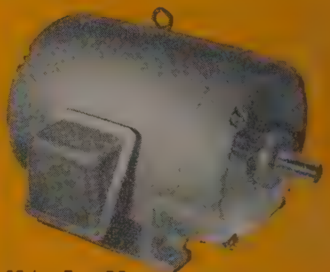
OTHER WAGNER MOTORS

In addition to the motors shown here, Wagner also furnishes Increment type motor and starter combinations, Multispeed motors, Wound rotor motors, Jet pump motors, Vertical and flange mounted motors, and Air-over motors. Consult your nearby Wagner Sales Engineer, or write for information.



¼ hp Type RK

Capacitor-start. General purpose single-phase motors that operate in any position—provide quick, trouble-free starting—pack plenty of power into little space. ¼ through ¾ hp. Also in integral ratings through 5 hp.



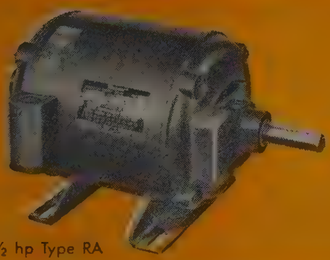
50 hp. Type DP

Doubly Protected (Type DP). Cast iron frames and endplates protect against corrosion. Drip-proof enclosures are designed for protection against falling or splashing liquids. Sleeve or ball bearing, 1 through 125 hp.

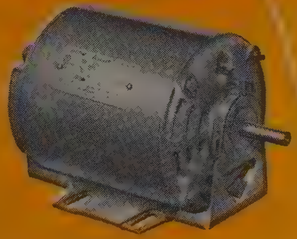
400 hp Type ZP

Tube Ventilated. Cooler running motors for heavy duty applications—big fans, blowers, pump drives. Tube cooling system holds operating temperatures within specified limits. Standard TEFC or explosion-proof through 500 hp.

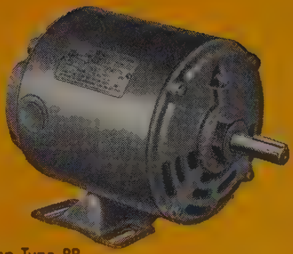
FRACTIONAL HP MOTORS


½ hp Type RA

Repulsion-start induction. Single-phase motors that make tough starts easy. Start heavy loads with extremely low starting current—stand up under long service. ½ and ¾ hp. Also in integral ratings through 5 hp.

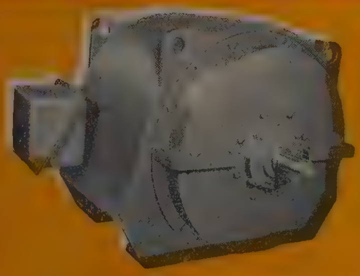

¼ hp Type RB

Split-phase. Small, light weight single-phase motors designed for low starting torque requirements. These motors can solve many application problems economically. 48 frame, ⅙, ¼, ⅓ hp.


⅓ hp Type RP

Polyphase Squirrel-cage. General purpose, normal torque polyphase motors in fractional horsepower ratings. 56 frame motors for machine tools, pump, fans, compressors where polyphase power is used.

INTEGRAL HP MOTORS


900 hp Type RP

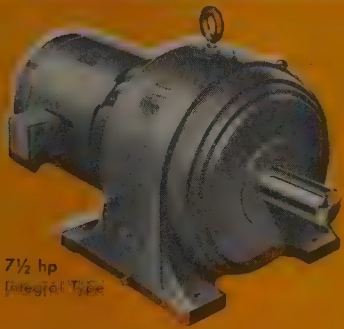
Open Type Polyphase Squirrel-cage. Drip-proof. Suitable for all general purpose applications. In 583 frame and larger steel frames. Sleeve or ball bearings. Ratings through 1000 hp.

30 hp Type JP

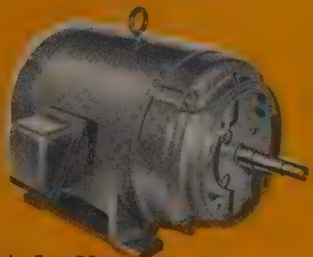
Extra Protected (Type EP). TEFC motors give complete protection against dust, abrasives, fumes or chips. Cast iron frames protect against corrosion. Also in Explosion-proof (Type JP). Ribbed frames, 1 to 100 hp.

10 hp Type RP

Extra Quiet Polyphase. Smooth running, resilient mounted motors, with sleeve or ball bearings, in ratings through 10 hp. Can be mounted on walls or ceilings, as well as in normal horizontal position.


7½ hp
Integral Type

Gearmotors. These compact gearmotors have greater than usual capacity, cast iron frames and housings for corrosion resistance, are available with open-protected or TEFC motors. Integral-type or all-motor type.


25 hp Type DP

Close-coupled Pump Motors. These normal torque polyphase motors, in ratings 1 through 100 hp, are available in face mounted models with special shaft extensions, for direct connection to centrifugal pumps.

7½ hp Polyphase

Hermetic Motors. For sealed refrigeration and air conditioning units, Wagner builds hermetic motors in both single-phase and polyphase squirrel-cage types, in fractional and integral ratings to 600 hp.

WM59-15

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Famous Shutlbrak Quick-Make, Quick-Break Mechanism. Front Operation Permits Close Ganging.

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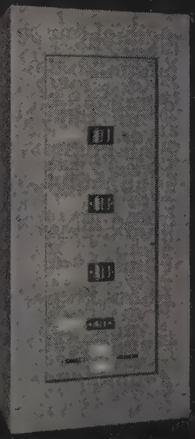
Circuit Breaker—2 to 42 Circuits.



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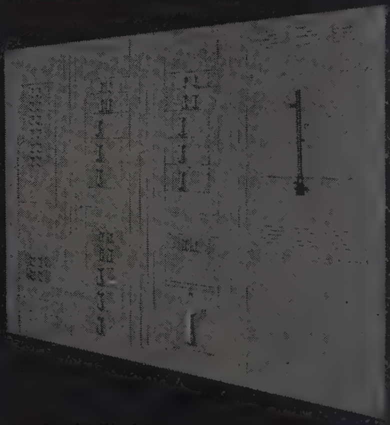
Circuit Breaker Type. All Steel Front.
15 to 600 Ampere—600 Volts or Less.



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Fusible and Circuit Breaker Types.
Front or Back-Connected.

Helping to develop the most satisfactory solutions to every problem of secondary power distribution and control has been the task of Frank Adam Electric Company since 1891.

Whatever the problem involving electrical equipment, take advantage of Frank Adam's 70 years of engineering and manufacturing "know-how" without obligation.

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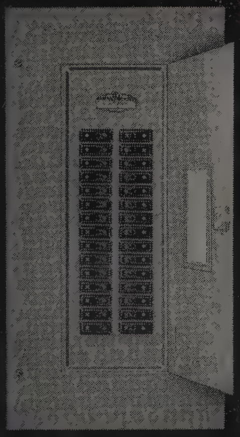
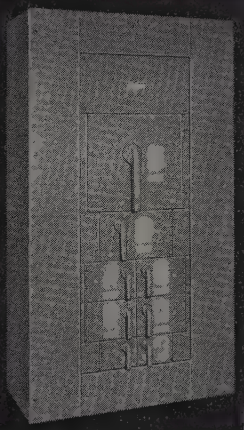


LIGHTING PANELBOARDS

Plug-In or Bolt-On Circuit Breaker Types.



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Last Word in Heavy Duty Fusible Protection.

POWER PLUGIN BUSDUCT

Plug-In Outlets 10' Centers.
250/1500 Amps., 600-V. AC.

MIDGET BUSDUCT

Extends Busduct System for Less Than Wire, Cable and Labor Costs. 100 Amps. Unfused, Fusible or Breaker Plug-In Units.

NON-COMBINATION

Starter and Fusible Switch Assembled.

COMBINATION

Single Enclosure With Starter and Switch or Starter and Breaker

PLUG-IN MOTOR STARTER UNITS

Plugs into Panelboards or Switchboards. Eliminates Separate Motor Controls.

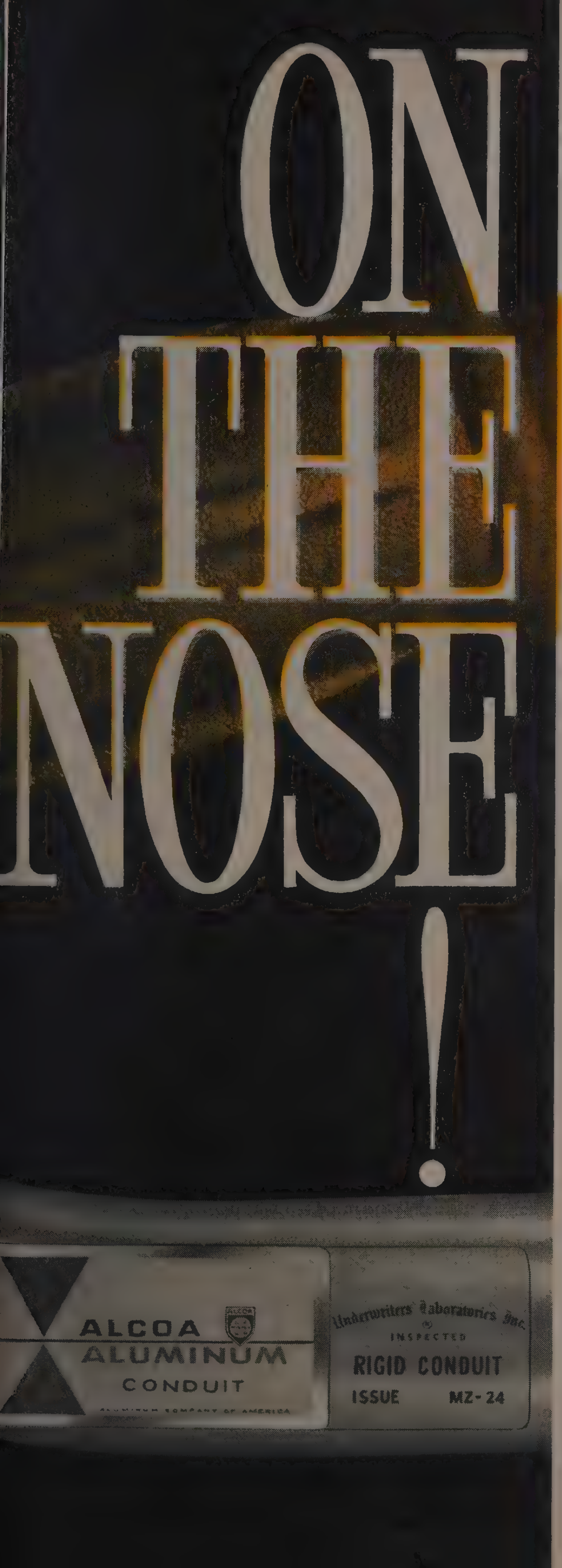
No matter what the size and complexity of the project—no matter if the need is for the largest switchboard or the smallest safety switch—the Frank Adam name upon it is a warranty of unsurpassed quality and craftsmanship, protection and durability.

Give your clients every benefit in safety, dependability and economy of the "industry's finest"—specify, insist on, Frank Adam Electrical Equipment.

Write for catalog literature

FRANK ADAM ELECTRIC COMPANY SINCE 1891
P. O. BOX 357, MAIN P. O. • ST. LOUIS 66, MO.

busduct • panelboards • switchboards • service equipment • safety switches • load centers • Quikheter



...just one of the reasons why Alcoa aluminum electrical rigid conduit is so easy to install

No spring-back in aluminum conduit means bends "on the nose" every time.

For small sizes, use a hickey or an EMT bender (one size larger). Regardless of size, mechanical and hydraulic benders make one-shot, uniform bends with a minimum of time and effort.

What else is there to look for in conduit?

Weight Alcoa aluminum conduit weighs only one-third as much as steel conduit. From warehouse to erection site there is only one-third as much weight to lift, load, carry and erect.

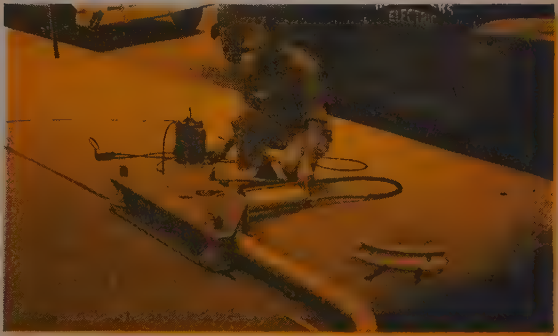
Cutting and threading With hacksaw on small sizes and power on large, cutting is quick and easy. Use sharp dies and regular cutting oils, and get clean, well-formed threads every time.

Wirepulling Wire aluminum conduit quickly, easily—using a plastic "rigid" rope fish tape, a flexible round steel tape, or a pressure-operated gun and plastic pulling rope. Alcoa conduit is factory lubricated for easy pulling.

Don't forget, too, that Alcoa aluminum conduit makes a good investment for your *customers*. It's corrosion-resistant, nontoxic, nonmagnetic, nonstaining, neat in appearance, with a seemingly endless service life.

Get all the facts and figures for your next job. Additional information and help are available from your nearby Alcoa-Rome representative. Or write to Dept. 7-51, Rome Cable Division of Alcoa, Rome, New York, for free technical literature.

EASY TO BEND. Alcoa aluminum conduit can be bent quickly, easily. Use EMT benders or hickeys with sizes to 1¼ inch. Standard power benders (below) can be used on all sizes.

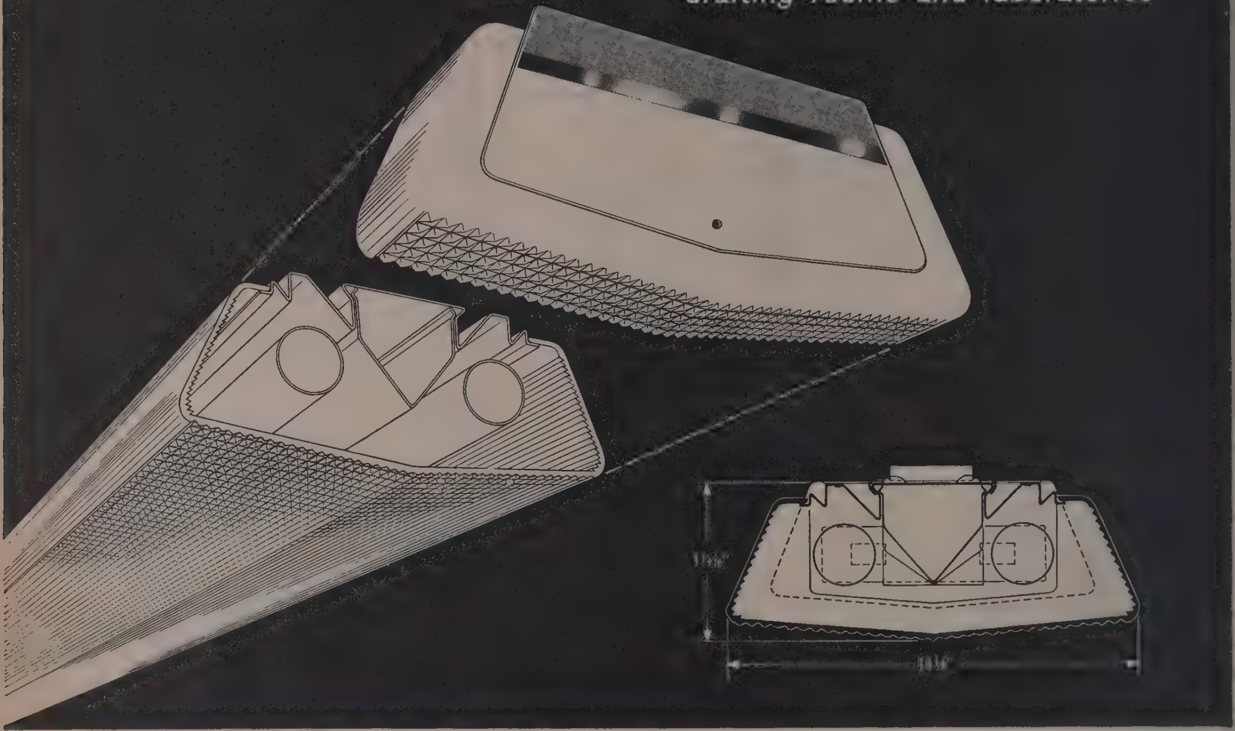


ALCOA
ROME CABLE
DIVISION

The WAKEFIELD PHOTOMETRIC

TRADE MARK

is a completely new injection-molded refracting luminaire for on-ceiling or stem mounting in schools, colleges, offices, libraries, drafting rooms and laboratories



Catalog No. PHR-214 (Styrene) – 4 ft.
Catalog No. PHR-214-AA (Acrylic) – 4 ft.

Catalog No. PHR-218-T (Styrene) – 8 ft. tandem
Catalog No. PHR-218-TAA (Acrylic) – 8 ft. tandem

Wakefield designers and engineers have lavished time and care on the development of the Photometric. The result is a luminaire for those who want the finest engineered lighting in a brilliantly styled package. Here are a baker's dozen reasons why:

1. Beautifully styled injection molded 4′ refractor available in styrene or acrylic.

2. Designed for either close ceiling or stem mounting; sliding clamp hanger to facilitate stem mounting.

3. No opaque metal between units, thus eliminating distracting contrasts when units are connected in luminous rows.

4. Controlled brightness in direct glare zone.

5. Actual over-all depth less than 4″. Four and eight foot units, truly modular in length.

6. Less surface to clean than with louvered fixtures.

7. No-drip ballasts designed to meet newly proposed CBM higher output standards.

8. No visible screws, nuts, bolts, rivets, welds or knockouts.

9. High over-all efficiency.

10. Snap-in-and-off reflector and ballast covers. Snap-in-and-out sockets for easy replacements.

11. Refractor removable from either side without tools or squeezing. No hidden latches or catches—simply lift, slide and remove with hinging action.

12. All steel parts white enameled.

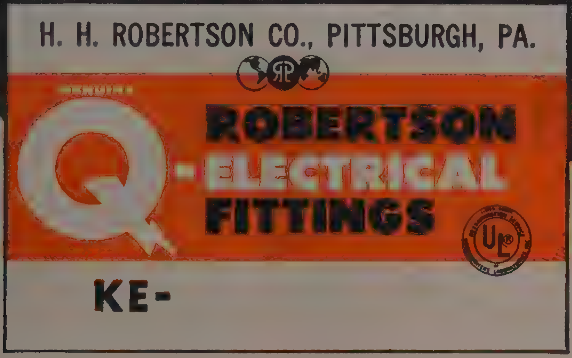
13. CBM/ETL, HPF ballasts. IBEW, UL/CSA labeled.

In stock now at leading distributors in U. S. and Canada

WAKEFIELD

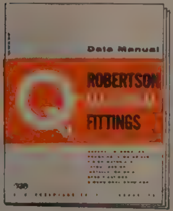
THE WAKEFIELD COMPANY—VERMILION, OHIO
WAKEFIELD SOUTHWEST COMPANY—OKLAHOMA CITY, OKLA.
WAKEFIELD LIGHTING LIMITED—LONDON, ONTARIO

look for this new label



when you buy electrical fittings for wiring cellular steel floors

As the inventor of the cellular steel subfloor system, the Robertson Co. has been manufacturing a complete line of electrical fittings for more than a quarter of a century. Now it announces a new line of fittings to go along with the standard line. Designed to handle high capacity wiring needs with ease of installation and freedom of layout, they will be merchandised by Robertson's field force of 160 men in every part of the country.



Use the coupon to write for our new 56-page Data Manual. It contains general information, roughing-in materials, finish materials, layout design, installation data, specifications and dimensional drawings.

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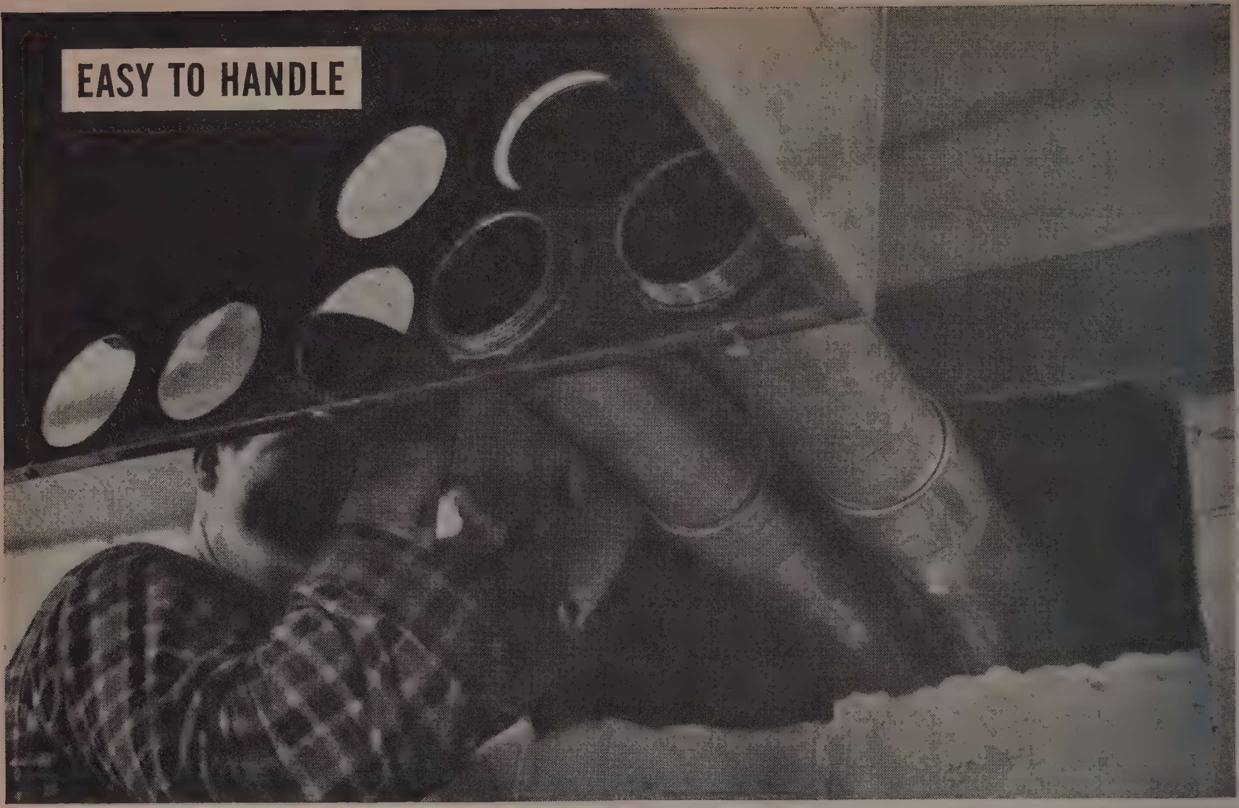
In England—Robertson Thain Ltd., Ellesmere Port, Cheshire
In Canada—Robertson-Irwin Ltd., Hamilton, Ontario, Edmonton, Alberta

H. H. ROBERTSON COMPANY
2405 Farmers Bank Bldg., Pittsburgh 22, Pa.
Please send new Q-Electrical Fittings Data Manual
NAME__________
TITLE__________
COMPANY__________
ADDRESS__________
CITY__________ STATE__________



Reynolds Aluminum Rigid Conduit

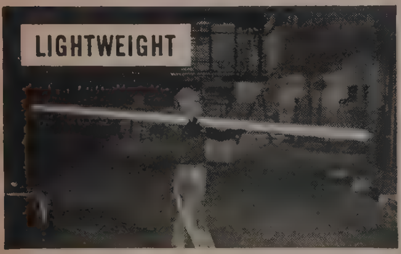
LOWERS INSTALLATION COSTS

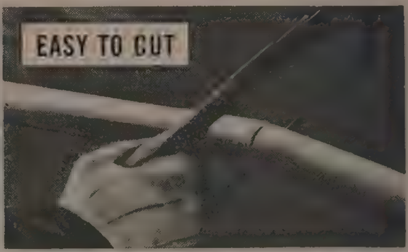
Here's why: Reynolds Aluminum conduit bends and forms easily and accurately. And, because aluminum is so lightweight—weighing one-third as much as steel, it can be handled and installed easily. Important to everyone concerned with maintenance is the fact that aluminum can't rust ever—and also resists corrosion due to weather and most industrial atmospheres. Even threads cut on the job can't rust.

Reynolds Aluminum Rigid Conduit is non-magnetic, reduces voltage drop, makes longer runs or smaller conductors possible.

For complete information and names of Reynolds Aluminum Rigid Conduit distributors, call your Reynolds Sales Office or write *Reynolds Metals Company, Box 2346-ET, Richmond 18, Va.*

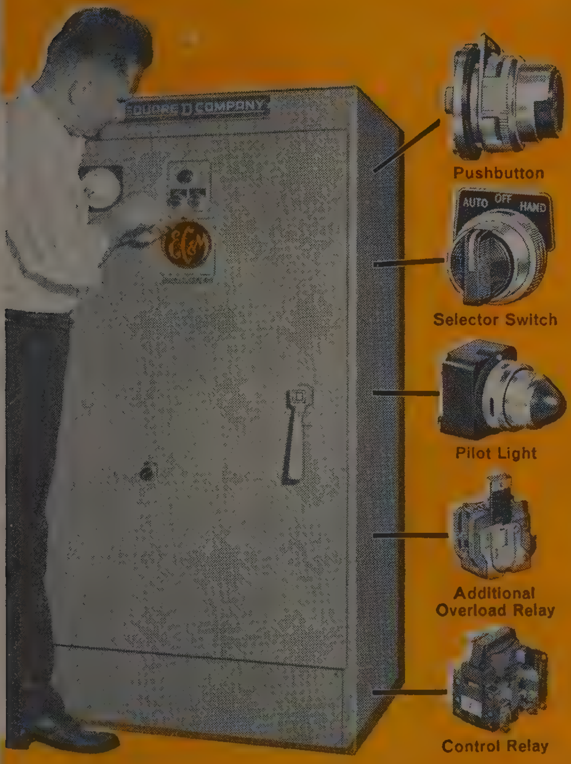
REYNOLDS ALUMINUM





Watch Reynolds TV show "Harrigan & Son", Fridays—ABC-TV

FAST DELIVERY of SIZE 6, 7 & 8 STARTERS



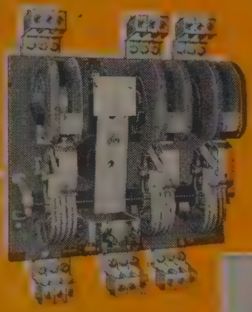
PRE-ENGINEERED MODIFICATIONS eliminate Special Engineering

Square D NEMA Size 6, 7 and 8 magnetic starters are now built with a plate in the door to accommodate modifications when needed. The same modifications which have long been available on Square D starters through Size 5—pushbuttons, selector switches, pilot lights, additional overload relays, auxiliary contacts—can now be added to the larger starters without special engineering.

This means fast processing of your order, quick delivery of your starters. What's more, you can make the same modifications in the field. The wiring diagram shipped with each starter shows exactly how to do it.

Available in ratings up to 900 hp, Square D Size 6, 7 and 8 starters can be ordered as open devices, or in general purpose, dust-tight and water-tight enclosures.

- With Square D Size 6, 7 and 8 starters, you get DC-operated (self-contained DC supply) mill-type contactors—at no extra cost. Exclusive Line-Arc construction dissipates heat, provides longer contact life. Self-lubricating bearings plus simple design make maintenance extremely easy. Another standard feature is lugs which accommodate either copper or aluminum cable.



- The magnetic starters shown at right—which range from Size 00 through Size 5—plus the Size 6, 7 and 8 starters described above, add up to a *complete* Square D line for *any* AC motor application.

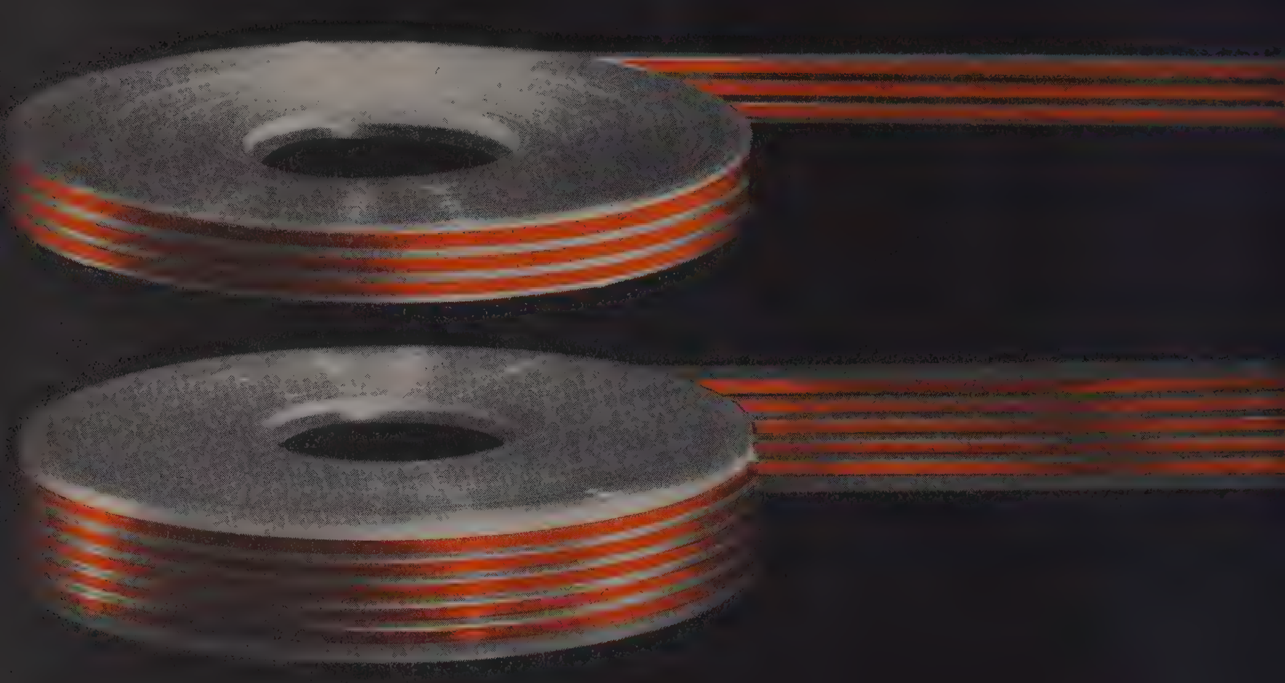
SQUARE D FOR A COMPLETE LINE
...SIZE 00 THROUGH SIZE 8

Write for Bulletin 8536. Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO
wherever electricity is distributed and controlled

5291

In ELECTRONIC COMPONENTS if it's news, expect it first from IRC



POLYSTRIP...the new easier w

FLAT, FLEXIBLE 3- and 5-CONDUCTOR CABLE SAVES INSTALLATION TIME AND MONEY

POLYSTRIP is a new concept in cabling, developed by IRC. Where time is money, the speed of installing POLYSTRIP results in big savings over older wiring methods. For instance, POLYSTRIP slips between wallboard seams, behind moldings, and through many openings, thus eliminating drilling and cutting of walls and woodwork. Ultra thin POLYSTRIP lies under floor coverings without causing bulges. It can be fastened to finished walls, ceilings and baseboards with double-backed doing away with need for conduit or plaster-cra hardware. The many features of this new product POLYSTRIP equally valuable for new construction modernization of existing buildings.

POLYSTRIP consists of uniformly spaced flat c conductors laminated with transparent plastics i very thin, flexible, flat cable. Already proved in indu electronic equipment, it is now applicable for hi-fi, pa signalling and alarm systems, programming, wired re

Installs behind surbases

Lies under floor coverings

Conceals easily behind wallpaper

Saves drilling through walls an

make low-voltage interconnections

ion control and many other installations.
TRIP Installer's Kit . . . Available now at
cal distributors.

IRC

RNATIONAL RESISTANCE COMPANY
orth 13th Street, Philadelphia 8, Pennsylvania

POLYSTRIP INSTALLER'S KIT SAVES 47% OVER SEPARATE PRICES OF ITEMS. IT INCLUDES EVERYTHING THAT'S NEEDED FOR ONE OR MORE INSTALLATIONS.

1—75-foot roll of 5-conductor POLYSTRIP cable
1—75-foot roll of 3-conductor POLYSTRIP cable
6—#5PWR (splicing type) connectors* for 5-conductor cable
2—#5PWA (wire lead type) connectors* for 5-conductor cable
6—#3PWR (splicing type) connectors* for 3-conductor cable
2—#3PWA (wire lead type) connectors* for 3-conductor cable
1—50-foot roll of double-backed pressure tape
1—Stripping tool
1—Data/instruction booklet

SPECIAL INTRODUCTORY PRICE $27^72

*T & B POS-E-FLEX connectors

tween wallboard seams

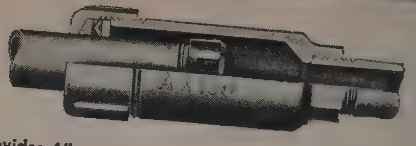
Folds flat for workmanlike angles

Attaches quickly with pressure tape

50 to 100% greater current capacity

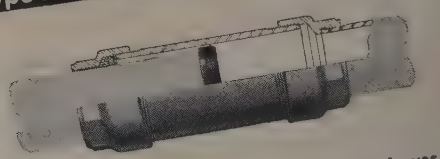
in the long run... it's O.Z.

Type AX



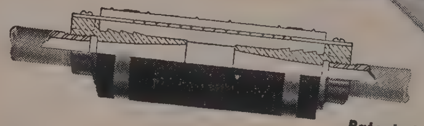
Provides 4″ expansion, contraction movement. Malleable iron head, body Hot Dip Galvanized. Weatherproof head sealed by factory-installed high grade graphite packing. Insulating conduit end bushing eliminates cable abrasion. 10 sizes for conduit ½″ to 4″ diameters.

Type EX



Permits 8″ conduit movement. Optional length sleeves, additional cost. Weatherproof head sealed by factory-installed high grade graphite packing. Insulating bushings prevent cable abrasion. Hot Dip Galvanized finish. 12 sizes for ½″ to 6″ conduit diameters.

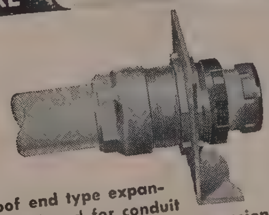
Type DX



Patented

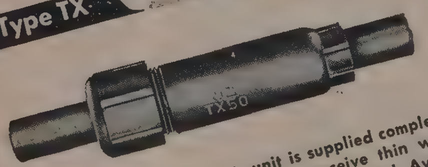
Compensates for deflection, expansion, contraction. ¾″ movement all directions from normal; 30° angular movement. Also used as vibration damper between conduit sections. 10 sizes. Watertight (NEMA 4) and submersible under 25 ft. head of water.

Type EXE



Weatherproof end type expansion fitting. Designed for conduit terminating in junction box, where expansion, contraction take place. Supplied complete: locknuts, bushings. Standard finish, Hot Dip Galvanized. 12 sizes.

Type TX



Similar to the Type AX, this unit is supplied complete with extension nipples, ready to receive thin wall couplings. Standard finish is cadmium plated. Available in 6 sizes for conduit ranging from ½″ to 2″.

for the longer line of EXPANSION FITTINGS

In the long run, no line of conduit is more dependable than its components. When it comes to dependability in expansion fittings, look to O. Z. as the line that measures up! Five basic types provide the dependable answer to your fitting problems in conduit expansion, contraction, and deflection. O. Z. is the dependable line because it's the line with the *right size*, the *right type*, for every requirement! Types AX, DX, EX and EXE available in aluminum at no extra cost.

O.Z.

ELECTRICAL MANUFACTURING CO., INC.
262 BOND STREET • BROOKLYN 17, N. Y.

- CAST IRON BOXES
- CABLE TERMINATORS
- POWER CONNECTORS
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- GROUNDING DEVICES
- CONDUIT FITTINGS
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Twice the work in half the time!

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PLASTIC
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Does the work of rubber tape *and* friction tape! Saves time with swift once-only splicing . . . looks better, lasts longer because it sticks and *stays*, conforming to any shape. Low bulk makes it especially good for neat, close tolerance work. Won't creep or thin in wide range of temperatures. Costs no more. Anyway you look at it, BULL DOG VINYL PLASTIC is economy all around! BULL DOG (.007″ thickness) has minimum dialectric strength of 10,000 volts.

There's a BULL DOG TAPE for every purpose

- *Friction*
- *Rubber*
- *Plastic*

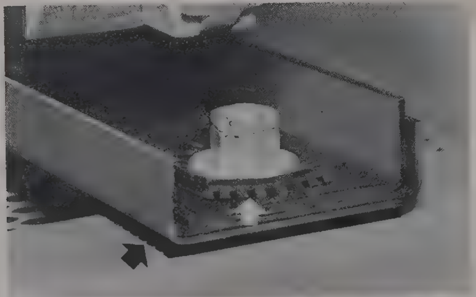
Sold only
through verified
wholesalers

AMERICAN BILTRITE RUBBER COMPANY
BOSTON WOVEN HOSE & RUBBER DIVISION
BOSTON 3, MASSACHUSETTS

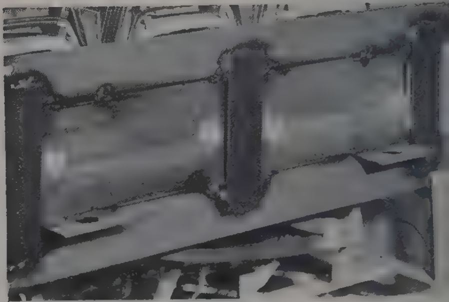
BOSTON

QHT® dry-type transformers

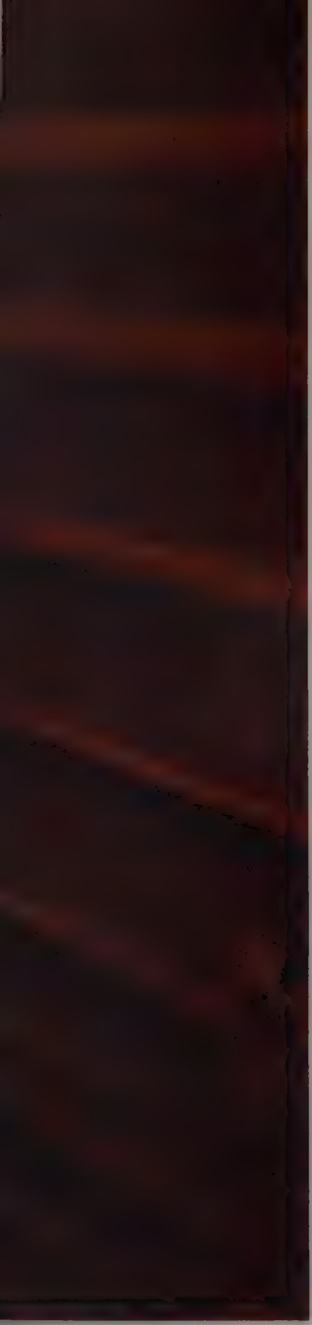
Research and testing in anechoic chamber of General Electric sound laboratory help maintain low sound levels of QHT transformers.



Built-in vibration-dampening rubber cushions isolate the rugged case of General Electric QHT transformers from core vibration, main source of transformer noise.



Welded steel clamps on higher ratings of General Elec
QHT dry-type transformers keep the core laminati
firmly in place to minimize vibration and reduce sou



How General Electric Designs "Quiet" Into QHT Dry-Type Transformers

Choosing the quietest transformer for schools, hospitals, office buildings, and other places where noise could be a problem is now easier than ever. General Electric's new line of QHT dry-type transformers is at least 15 decibels quieter than older designs, and the *actual rating appears on each transformer*. As the chart below shows, each rating of QHT transformers has a sound level equal to or less than the NEMA standard.

Full-time research and testing in General Electric's sound laboratory provide General Electric engineers with information needed to design and maintain the low sound levels of QHT transformers.

Vibration is minimized on larger size units by welded steel clamps which hold the transformer core in a rigid position. In addition, on QHT units rated 30 kva and up, vibration-dampening rubber cushions isolate the case from the core and coil assembly. Consequently, core vibration passing through mounting brackets and conduit to surrounding surfaces is practically eliminated.

QHT transformers also save production space because they offer savings up to 50 percent in weight and 67 percent in size compared with competitive dry-types. You can mount QHT units in out-of-the-way places near the load and save the cost of long, low-voltage feeders.

Installation is fast and easy. You wire QHT transformers from the front. Convenient dual-sized knockouts, large terminal compartments, solderless connectors, and numbered terminals save time.

You can get 24 hour delivery on most models from your nearby General Electric distributor. Call him for more information, or write for GEA-6907A "QHT Specifier's and Buyer's Guide" to Section 411–15, General Electric Co., Schenectady 5, N. Y.

**Registered trademark of General Electric Co., for quiet, high temperature, dry-type transformers.*

KVA	QHT DECIBELS†	NEMA STANDARD
BELOW 5	40	45
5–9	45	45
10–30	45	50
37½–112½	45	55
150	45	60
167	55	60
225–300	55	62
500	60	—

Measured per NEMA Standard St. 1.411. The average office has sound levels from 55 to 65 decibels.

Progress Is Our Most Important Product

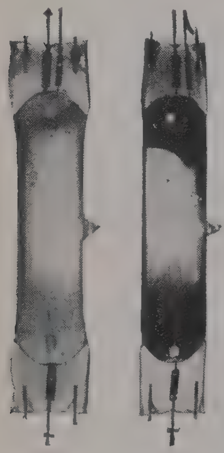
GENERAL ELECTRIC

First from General Electric (1958)... another bright idea that became a better lamp...Bonus Line Mercury

works 6,000 hrs. overtime, cuts your customers' costs

Nearsighted Mister Magoo says . . . "1958? How time flies! That's the year the Nautilus—gallant lads!—went under the North Pole, and General Electric developed the Bonus Line Mercury lamp. Happy birthday, Bonus Line. Egad! Who built the ship in this bottle?"

Look again, Mister Magoo. It's General Electric's special new electrode. Up through the 400-watt size, it gives your customers 12,000 hours of useful life *—or twice as much as the old non-bonus line.* And the higher wattages (700 and 1000) offer 50% extra useful life.

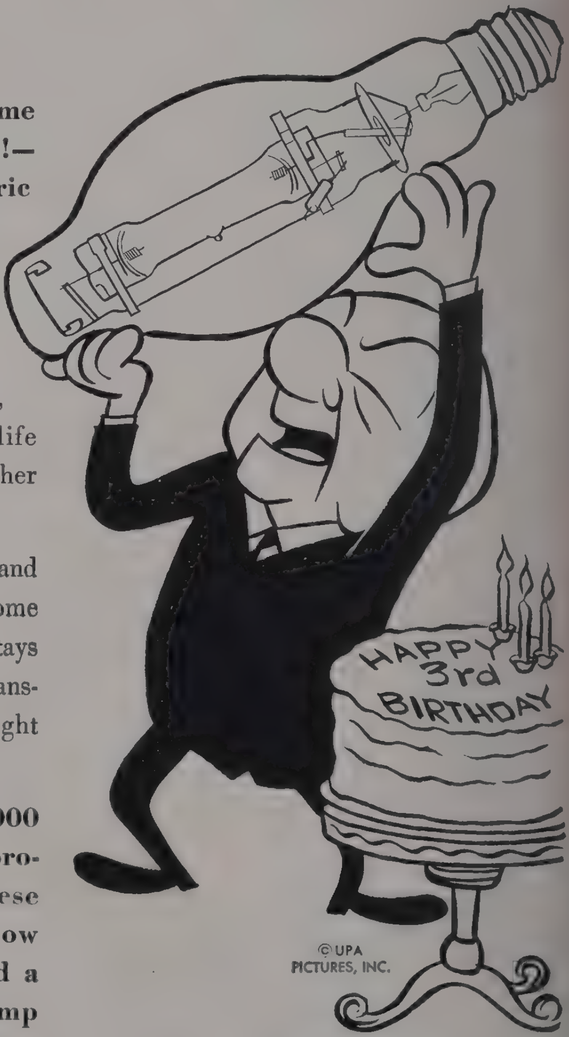


NEW OLD

Compare these two arc tubes, and you'll see where the extra hours come from. Notice how the new one stays white instead of blackening. The translucent *white* deposit lets more light come through.

Result: more light after 12,000 hours than ordinary lamps produce after 6,000 hours. These extra hours are free. And now manufacturing efficiencies and a growing demand for this lamp enable us to reduce its price 15%. Other popular G-E 400-watt mercury lamps are reduced 8-13%.

Important: All G-E mercury lamps are now made only in *heat resistant glass,* to prevent glass deterioration. Ask your G-E distributor for more details. General Electric Company, Large Lamp Dept. C-19, Nela Park, Cleveland 12, Ohio.



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Progress Is Our Most Important Product

GENERAL ELECTRIC

OSPITAL
ATIENTS
OK BETTER,
E BETTER,
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ITH NEW
AY-BRITE
ANQUILITE

...A "Decidedly Better" Hospital Bed Light!

- Switching provides reading light, night lite and general illumination
- Convenient electric outlet for examining light, electric razor or radio
- Reduces glare . . . ideal for multiple patient rooms and wards
- Available in 2 or 4-foot lengths, stainless steel or baked white enamel finish

You can actually *see* the difference TRANQUILITE makes! Cold, clinical looking hospital rooms take on new warmth, become more inviting. Patients perk up.

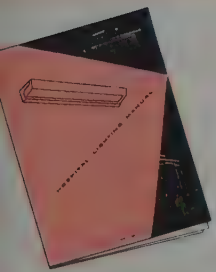
In older rooms, defects seem to disappear under TRANQUILITE's soft illumination, evenly diffused through CLEAR-TEX®-type enclosures.

Whether you're looking for the most efficient way to light new rooms, or an economical way to modernize older ones, Day-Brite TRANQUILITE is the right light for you!

TRANQUILITE is just one of a complete line of "Decidedly Better" Day-Brite fixtures that satisfy every hospital lighting need . . . all *easy to clean/easy to install / easy to maintain.* For full details, phone your Day-Brite representative listed in the Yellow Pages, or . . .

IMPORTANT: Read all about the newest development in **Air Diffusing** lighting fixtures (on other side)

JUST DETACH AND MAIL . . . NO POSTAGE NEEDED



Mail coupon for FREE "Hospital Lighting Manual"

Informative 24-page booklet gives current IES recommended illumination levels and practical lighting lay-out suggestions for all hospital areas. No obligation. Just fill out coupon, detach and mail TODAY. No postage needed!

AY-BRITE

NATION'S LARGEST MANUFACTURER OF
OMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

FIRST CLASS
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St. Louis, Missouri

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DAY-BRITE LIGHTING, INC.
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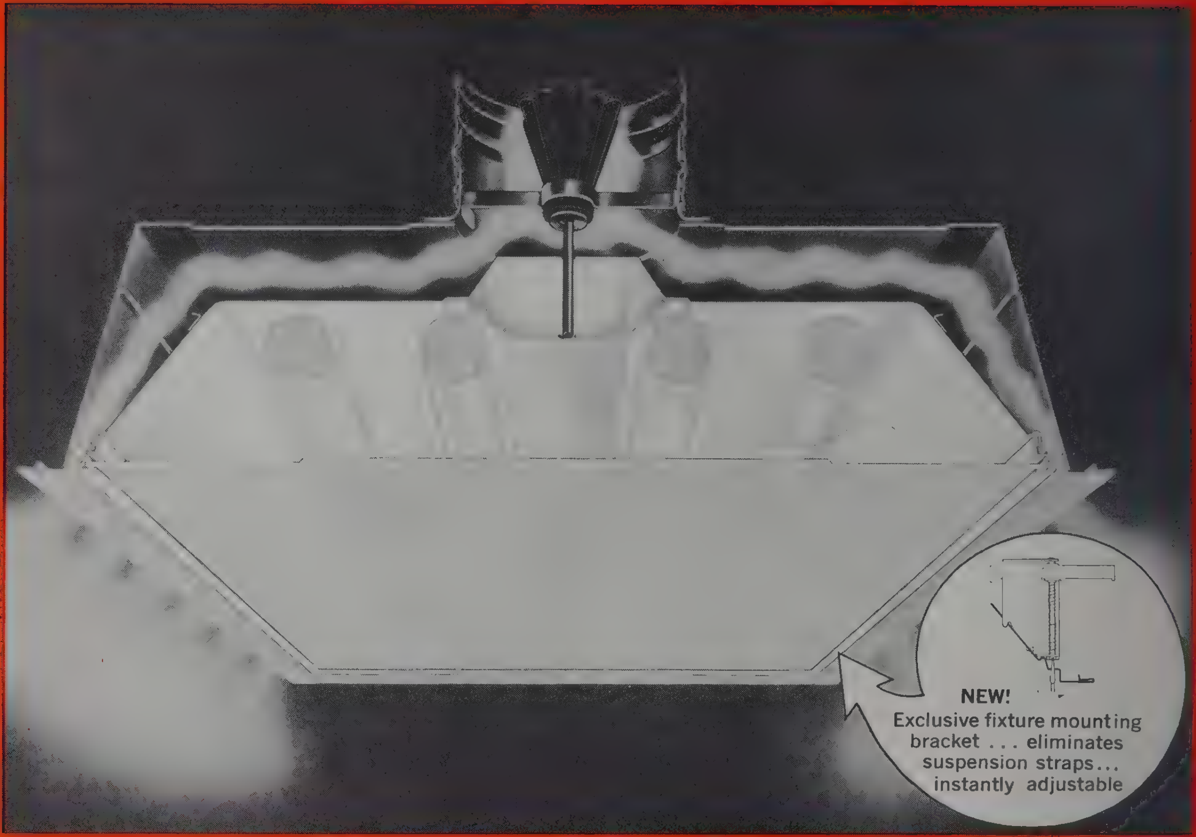


NEW!
Exclusive fixture mounting bracket . . . eliminates suspension straps . . . instantly adjustable

GET THE FACTS ON DAY-BRITE'S NEW AIR DIFFUSING LIGHTING FIXTURES!

MAIL COUPON FOR FREE 24-PAGE GUIDE TO "COMFORT CONDITIONING WITH LIGHT AND AIR"

No Postage Needed—Just Detach and Mail

DAY-BRITE LIGHTING, INC.
6260 N. Broadway, St. Louis 15, Mo.

☐ Please send me free "Comfort Conditioning with Light and Air."
☐ Please send me free "Hospital Lighting Manual."
☐ Please have Day-Brite representative contact me.
☐ I would like a free estimate with no obligation.
☐ New construction ☐ Re-lighting present facilities

Company Name____________________

Name________________Title________

Address____________________

City__________Zone____State______

My Electrical contractor is________________ ECM

- FOR CLEAN, UNCLUTTERED CEILINGS h quality lighting and air distribution combined in beautifully designed unit.
- NO SACRIFICE OF LIGHTING EFFICIEN Day-Brite's patented double-wall construction isolate flow from lamps. Requires no more cleaning than ord fixtures.
- MORE UNIFORM AIR DISTRIBUTION. E lighting fixture can also be an air diffusing source use in combination with fixtures equipped with mat enclosing elements.

Get all the facts you're looking for on Day-Brite Diffusing Lighting Fixtures in a handy booklet. Inc full performance data and information required for i lation planning. Mail coupon today for your free *Day-Brite Lighting, Inc., St. Louis, Mo., and Santa C Calif. In Canada: Amalgamated Electric Corp., Toronto 6, Ont.*

DAY-BRITE

NATION'S LARGEST MANUFACTURER OF
COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

IMPORTANT: Read all about the new, "decidedly better" Hospital Bed Light (on other side)

In 1858, the first Atlantic Cables were insulated with Bishop Gutta Percha.

Today, Bishop answers industry's critical demands . . . from the tropics to polar regions.

This is the world of BISHOP ELECTRICAL INSULATION

114 years of continuous development and service has established Bishop as a leading producer in the electrical insulation field. Bishop's high standard is maintained in a comprehensive line of plastic and synthetic rubber tapes, epoxy compounds for cable splicing and special compounds for cable repair.

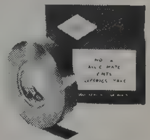
Bi-Seal Self Bonding Electrical Tape

Exclusive Bishop polyethlene base tape is unexcelled for all-weather application in communication and power distribution wire and cable splicing. Available in ½", ¾", 1", 1½", 2", widths.

Superior corona and ozone resistance
Fuses into solid mass
Moisture, corrosion and chemical resistant
High dielectric strength
Superior aging and weathering
Long storage life

Write for catalog or specific data.

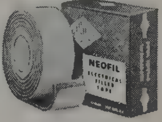
Other Bishop Tapes



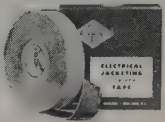
No. 85 All-Climate Vinyl Electrical Tape

No. 30 High Voltage (Butyl) Splicing Tape

No. 125 Electrical (Butyl) Filler Tape

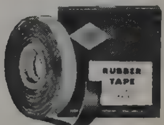


NEOFIL (Neoprene) Electrical Filler Tape



BI-PRENE (Neoprene) Electrical Jacketing Tape

VINYL ELECTRICAL TAPE
No. 1 (.007") and No. 2 (.010")



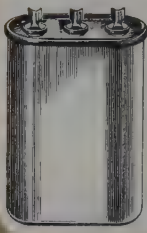
RUBBER TAPE

BISHOP

Manufacturing Corporation, Cedar Grove, Essex County, N. J.

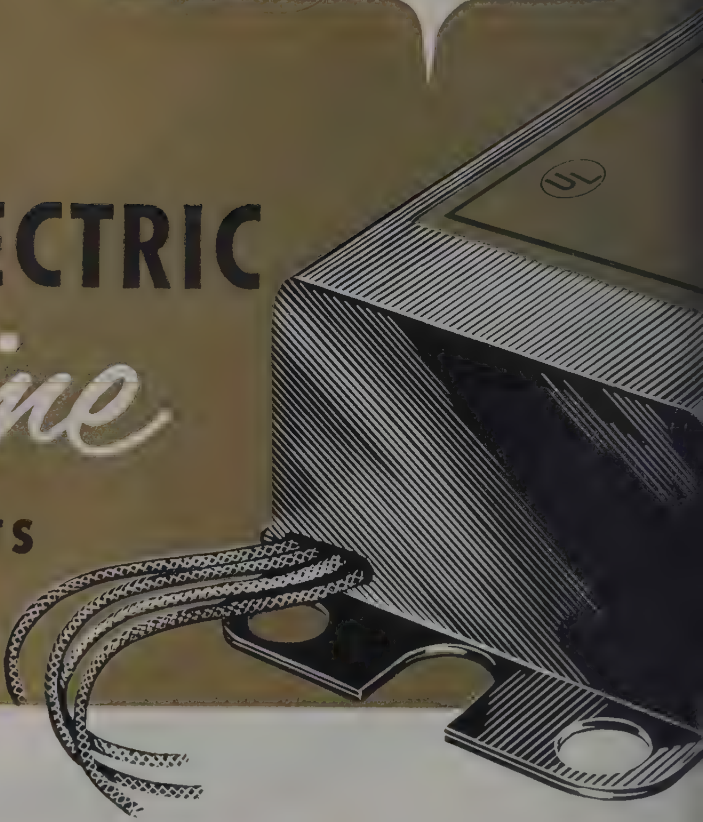
Another **NEW** General Electric Ballast Development . . .

THIS CAPACITOR IS DESIGNED TO PREVENT RUPTURE!



New Thermal Link deep within capacitor roll protects against excessive internal temperatures which may cause rupture of the capacitor case. Also, a new bushing assembly acts as an effective barrier to seal against bushing seepage. Result: longer ballast life.

Introducing
NEW
GENERAL ELECTRIC
Bonus Line
Fluorescent Ballasts



DESIGNED TO . . .

- eliminate hazards to people and property
- eliminate need for individual ballast fusing
- eliminate leakage
- provide longer ballast life
- be interchangeable with standard models

WITH NO SACRIFICE IN SOUND PERFORMANCE!

Another NEW General Electric Ballast Development . . .

SPECIAL THERMAL PROTECTOR makes ballasts safer than ever before!

Unique Thermal Protector is designed to de-energize the ballast *permanently* at end-of-life failure, preventing compound softening and eliminating ballast leakage. This assures full-life protection against hazards to people or property.

General Electric proudly announces new Bonus Line fluorescent ballasts designed to offer you—for the first time—full protection against the hazards sometimes associated with ballast end-of-life failure.

This new ballast design, *available in most popular ratings for indoor commercial and industrial applications,* features two outstanding new General Electric developments that make it safer than standard ballast designs:

1. A new Thermal Protector has been developed and tested for several years in General Electric laboratories. The Thermal Protector de-energizes the ballast before it reaches the critical internal temperatures at end of life that cause ballast filling compound to soften or melt. This non-resetting Thermal Protector completely eliminates any need for individual ballast fusing.
2. A newly developed, two-way improved General Electric capacitor features a unique Thermal Link designed to overcome capacitor rupture and leakage which sometimes occur at end of life. Also, the new capacitor has a new bushing assembly which contributes to longer ballast life.

New Bonus Line ballasts are dimensionally, thermally, and electrically interchangeable with standard General Electric ballasts of same ratings. They meet—*and, in certain respects, exceed*—all appropriate industry standards. And you get all these ballast added values without sacrifice in sound performance. General Electric ballasts are still the quietest ballasts available!

In short, new G-E Bonus Line ballasts give you added years of safe, reliable, quiet performance. They're engineered to eliminate leakage, smoke—even the more violent conditions which sometimes occur at end of normal ballast life.

Your General Electric ballast sales engineer will be proud to give you full information on new G-E Bonus Line ballasts for your lighting applications. Contact your nearby G-E sales office or write for Bulletin GEA-6912 to Section 403-01, General Electric Co., Danville, Illinois.

HOW TO SPECIFY

To obtain the protection advantages of the new General Electric Bonus Line ballast features, specify "Ballasts shall be protected with non-resetting thermal protectors in the core and coil assembly and in the capacitor."

Progress Is Our Most Important Product

GENERAL ELECTRIC

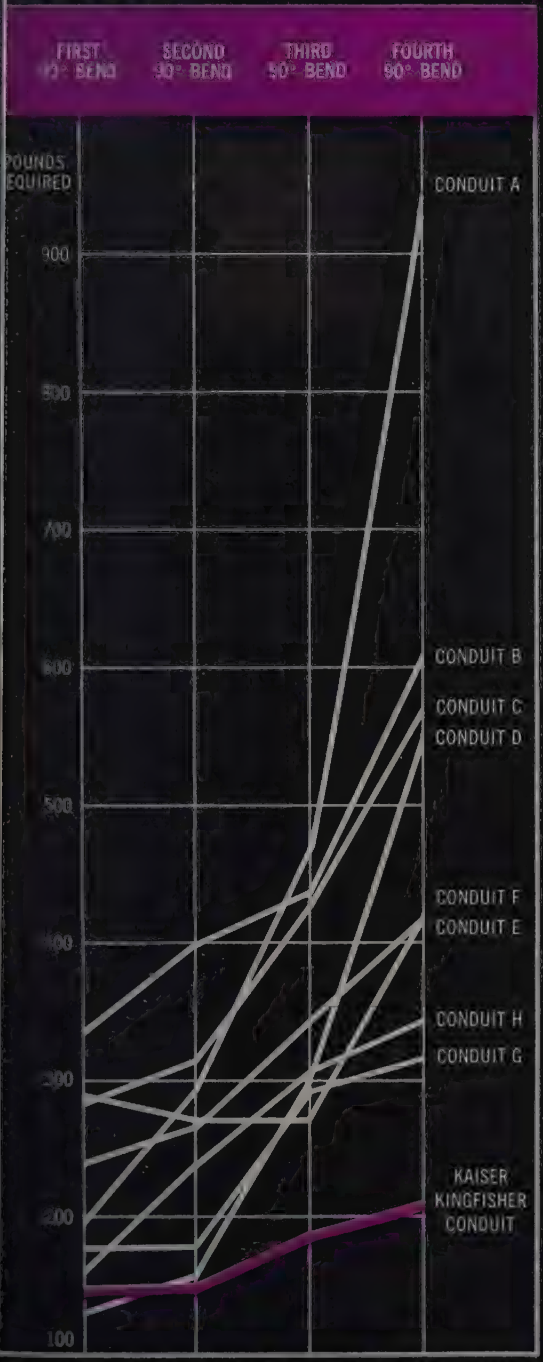
NEW!
KAISER ALUMINUM
KINGFISHER
ALUMINUM CONDUIT WITH K-40 SILICONE LINING

UTS FISHING WORK IN HALF!

ERE'S PROOF. This chart compares manpower quired to pull cable through conduit. New Kaiser ngfisher—with exclusive K-40 Silicone lining—illed 2.5% easier than galvanized steel conduit at e second 90° bend in tests . . . 36% easier than eel at the third bend . . . an amazing 61% easier an steel at the fourth bend!

UNDS OF PULL REQUIRED—ALUMINUM AND GALVANIZED STEEL CONDUIT *

t pulls** of three fresh #2 RHW through 1¼-inch conduit with rious lining materials.



*In nine galvanized steel tests, four resulted in cable breakage at the fourth bend.

*Details upon request.

◆ ◆ ◆

NOW AVAILABLE
COMPETITIVELY PRICED

◆ ◆ ◆

Your Kaiser Aluminum Electrical Distributor now offers immediate delivery of competitively priced Kaiser Kingfisher Conduit.

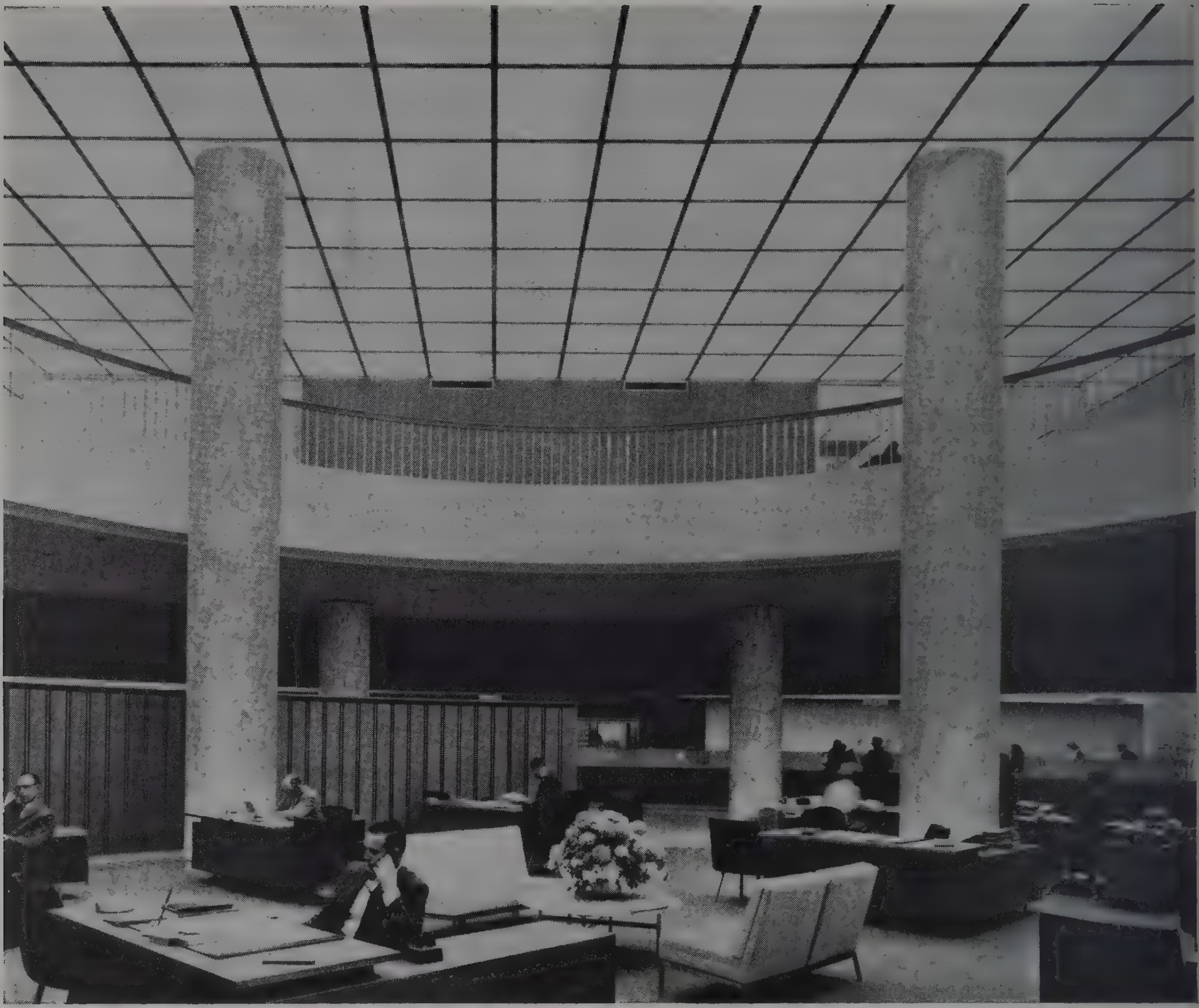
Only Kaiser Kingfisher combines advantages of aluminum and K-40 Silicone lining. Saves up to one-third the man-hours by lightweight handling and installation of aluminum . . . eliminates cable breakage . . . resists corrosion . . . cuts fishing work in half! Ask for Kaiser Kingfisher by name.

KAISER ALUMINUM *

NEW LEADERSHIP IN THE WORLD OF ALUMINUM

*Trademark Kaiser Aluminum & Chemical Corp.

See HONG KONG and MAVERICK weekly on the ABC-TV Network



Ceiling for the new California Bank main branch in Los Angeles. Interior designer, Henry Dreyfuss. Installed by Harold E. Shugart Co., Los Angeles. Ceiling made from BAKELITE Brand rigid vinyl sheet panels by Cepco, Inc., San Francisco, California.

A Bank Draws High Interest On Its LONG-TERM INVESTMENT IN LIGHTING

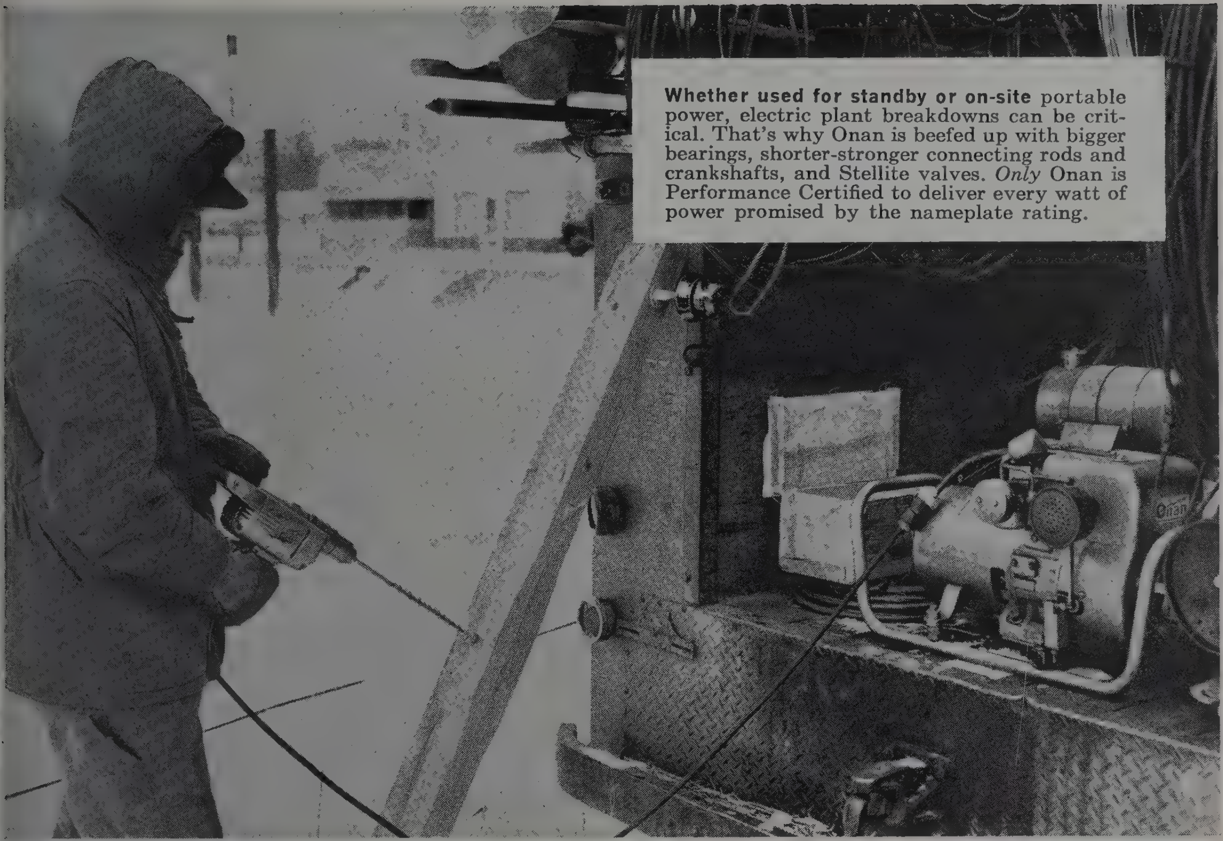
There's a friendly, refreshing note in this Los Angeles bank's brilliant lighting. Glare-free and shadowless, the luminous ceiling is a snowy expanse of translucent BAKELITE rigid vinyl sheets suspended beneath fluorescent fixtures. The huge panels, four feet square, consist of a top and bottom sheet with an air space between and are placed in a metal frame under tension to facilitate handling. For years to come, the ceiling will stay as beautiful as it is. Accelerated aging tests show high resistance to ultra-violet light.

Now . . . high impact resistance! BAKELITE rigid vinyl sheets are now available with *new high impact qualities* that provide extra resistance to hard knocks . . . the wear and tear of installation and maintenance . . . cracking and warping. These sheets are normally unaffected by moisture and detergents, and, because of their light weight, they are easy to install, remove, and maintain.

New designs or renovations can be given a lift with better lighting. Install luminous ceilings made with *high-impact* BAKELITE rigid vinyl sheet. For information, write Dept. IW-41E, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

UNION CARBIDE



Whether used for standby or on-site portable power, electric plant breakdowns can be critical. That's why Onan is beefed up with bigger bearings, shorter-stronger connecting rods and crankshafts, and Stellite valves. *Only* Onan is Performance Certified to deliver every watt of power promised by the nameplate rating.

Only Onan is certified to give you all the power promised by its nameplate

It's a fact that many electric plants on the market today do not deliver the output promised by their nameplate rating.

Every Onan plant is given a rugged workout *under full load* before it is shipped—*your assurance* that the Onan you buy is ready for hard work the day you get it.

But this isn't enough. Independent laboratory inspectors pull surprise inspections to double-check our tests and testing methods. They pull a plant off the line, run it, stop it, load it, overload it, check and recheck. Their torture test gives positive proof of Onan's quality. End result: *Onan's exclusive Performance Certification* . . . your assurance of getting every watt of power you pay for.

So when you're tempted by an electric plant "bargain," make sure its nameplate rating is not "inflated." Be sure you're getting full measure for your money. Remember, *the electric plant that shortchanges you in power output is no bargain at any price!* Only Onan is Performance Certified to deliver everything the nameplate promises.

See Onan electric plants soon. Compare before you buy. You'll find your Onan distributor listed in the Yellow Pages. Call him or write direct.

PERFORMANCE CERTIFIED

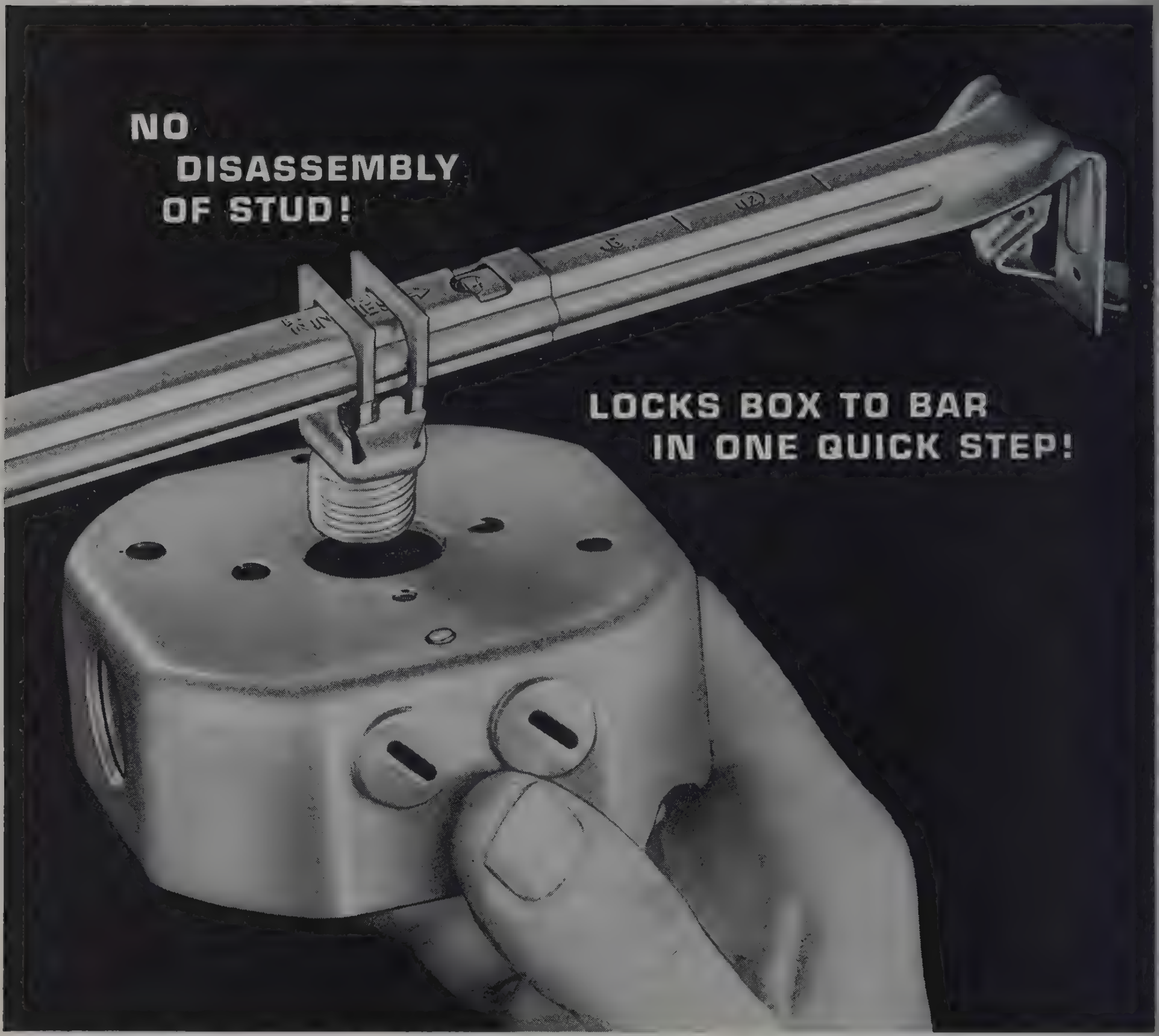
We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.

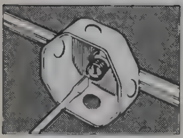
World's Leading Builder of Electric Power Plants

Onan

ONAN Division, Studebaker-Packard Corporation, 2575 University Ave. S. E., Minneapolis 14, Minn.

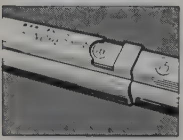
NEW EFCOR BAR HANGERS



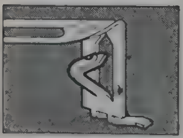


CUTS ASSEMBLY TIME —— Just remove the outlet box knockout, slip box over bar hanger stud, tighten with screwdriver, and you're set! No parts to remove and replace.

Plus these added features for fast, dependable installation!



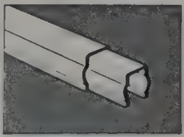
EXCLUSIVE LENGTH GAUGE
Lets you pre-set hanger bar length before installation.



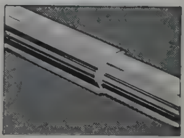
EXCLUSIVE GRIPPER PRONGS*
Permanently locks prong into wood.

*Pat. Applied For

HEIGHT GAUGE
Accommodates most common settings—easily snapped off for other applications.



EXCLUSIVE NON-SLIP BAR SECTIONS
Slide easily for proper length setting but will not fall apart.



HEAVY-DUTY CHANNEL DESIGN
Special rib-reinforced bar cross-section resists bending, twisting—takes 20% greater loads.

Available in both stud and no-stud assemblies. Can be reversed for additional installations. Just two bar sizes cover any length from 11½" to 26½". Also available in preassembled box and bar units. SEND FOR FREE SAMPLE.

Efcor

ELECTRICAL FITTINGS CORPORATION • 37-50 57th St. • Woodside 77, N. Y.

Niagara-Mohawk Power Corporation, Huntley Station, Buffalo, New York.

Power company selects Abolite...

Gets easy-on-the-eyes lighting, and holds the line on costs

INSTALLATION DATA

Abolite HMFAU-2400 Alzak aluminum uplight fixtures with 1000 watt color-improved mercury lamps. Ceiling height 65′, mounting height 55′, spacing 18′ x 24′. Average maintained footcandle level: 30.

Electrical Contractor:
Buffalo Electric Co.

Engineers at this power plant wanted high bay lighting that combined comfort with low installation and maintenance costs. They got it by installing Abolite fixtures equipped with 1000 watt color-improved mercury lamps.

Though these fixtures are mounted 55 feet high, they provide comfortable, glareless 30 footcandle average light throughout the building. Light directed upward through the fixtures' open tops washes out dark ceiling shadows. 35° shielding of lamp virtually eliminates glare.

Most important, this system costs less to buy and maintain than a comparable fluorescent system because fewer fixtures are needed. Maintenance costs are less, too, because air circulating through Abolite's open-top fixtures sweeps them clean of dulling dust.

For high bay lighting that combines both comfort *and* economy, specify Abolite fixtures. The complete line includes RLM-approved Alzak aluminum and porcelain enamel fixtures for use with all kinds of mercury and incandescent lamps. Write for more information.

ABOLITE *Lighting*

THE JONES METAL PRODUCTS COMPANY
West Lafayette, Ohio

STEEL

depend on steel conduit from Youngstown—the most complete line in the world

You cut with a steel saw. Bore with a steel drill. Thread with steel. Bend with steel. You use steel so often that you know how good it is. Today, it's better than ever. Steel . . . as strong, familiar, reliable conduit from Youngstown's modern mills.

Get Youngstown Buckeye and corrosion resistant Yoloy rigid conduit and EMT. Buckeye for standard installations. Yoloy where corrosion is a problem. Match your needs exactly with the quality Youngstown steel conduit made to meet them.

Choose Buckeye or Yoloy Hot Galvanized conduit. Even the threads are galvanized. Choose Buckeye Electro-Galvanized conduit. Clear enamel interior fishes easier. Choose Buckeye or Yoloy Black Enameled steel conduit. The finish won't wrinkle or crack when bent. Or choose Buckeye or corrosion-resisting Yoloy EMT. Electro-galvanized, coated inside and out with smooth clear enamel.

With any Youngstown quality steel conduit you get easier, kink-free bending. You get smoother threading. Clean, trouble-free handling. Faster fishing. Service masts you don't have to guy. And a modern raceway system that looks as good as it works.

On your next job, specify Youngstown steel conduit. It is readily available in sizes ½″ to 6″. Get prompt delivery from your electrical distributor.

Youngstown – growing force in steel

For complete information on Youngstown steel conduit, write, Dept. 26-A,
The Youngstown Sheet and Tube Company, Youngstown, Ohio

"We're very pleased with this Sylvania lighting installation," states John Haas, Supervisor of Electrical Engineering at Johnson & Johnson's New Brunswick plant. "Our production facilities have a cleaner appearance. We maintain our equipment easier and with greater safety. And our employees are much happier working under this new lighting."

SYLVANIA
Lighting
FIXTURES
Specify with Confidence

SYLVANIA LIGHTING FIXTURES . . .

First Aid for Production and Maintenance at Johnson & Johnson

At Johnson & Johnson's New Brunswick, N.J. plant—the home of Band-Aid Adhesive Bandages—clean surroundings, fast inspection and ease of mechanical maintenance are essential.

To maintain high efficiency in the manufacturing, processing and packaging of Band-Aid Plastic Strips, Johnson & Johnson recently installed new Sylvania industrial fixtures using Sylvania VHO Powertube lamps.

As a result, this production area now has 150 footcandles of quality illumination . . . and it was obtained at reasonable cost.

Sylvania's industrial fixtures using 1500 ma lamps have led to increased production, less waste and better overall efficiency in many plants.

If *your* production figures are not what you expect, take a close look at your lighting. And look to Sylvania fixtures to solve your lighting problems.

VITAL STATISTICS
Johnson & Johnson, New Brunswick, N.J.
Fixture Type—Sylvania 1500 Ma Industrial Units (Slotted Porcelain Reflector—10% upward component)
Lamp Type—Sylvania F96T12/CW/VHO (1500 ma)
Mounting Height—14′
Fixture Spacing—10′
Average Illumination—150 Footcandles

SYLVANIA LIGHTING PRODUCTS
A Division of SYLVANIA ELECTRIC PRODUCTS INC.
One 48th Street, Wheeling, West Virginia

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Tear this page at the perforations — keep it handy for ready reference. Reverse side shows typical specifications for Remote Control Switches. For complete information, write for Publication 609 and Catalogs 57-S1 & 57-S2.

HOW TO SPECIFY AUTOMATIC TRANSFER SWITCHES

To assist specification engineers in their important task of drafting the specifications for automatic transfer switches designed into power and lighting distribution systems, ASCO presents herewith a classic specification format. Left-hand column is devoted to those specifications particularly applicable to stand-by electric plant arrangements; the right-hand column shows those elements suitable for systems using either public utilities or electric plants as an emergency supply.

Common specifications (removed from their normal sequence) will be found beneath both columns.

WITH STAND-BY ELECTRIC PLANTS AS AN EMERGENCY SUPPLY... The stand-by plant shall be of the remote control type arranged to start and stop under the control of a pilot contact installed on the transfer switch.

An automatic transfer switch shall be provided with ..... poles for a normal source of ..... volts ..... phase ..... cycles, and an emergency source of ..... volts ..... phase ..... cycles. The transfer switch shall be arranged to close a pilot contact for remote starting of the stand-by plant 3 seconds after normal source failure or after drop in voltage on any phase to (specify one) ( ) 70% ( ) 90% or less. The load circuits shall not be disconnected from the normal service during the 3 second delay period. When the stand-by generator is delivering not less than 90% of rated voltage and rated frequency, the load circuits shall be transferred.

Upon restoration of the normal source to not less than (specify one) ( ) 90% ( ) 95% of rated voltage on all phases, load shall be retransferred to the normal source after a time delay of 5 to 25 minutes (adjustable). After retransfer to the normal source, the engine shall run for 5 minutes unloaded and then automatically shut down and be ready to start upon the next failure of the normal source. If the stand-by plant should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of the normal source.

The transfer switch shall include the following accessories:

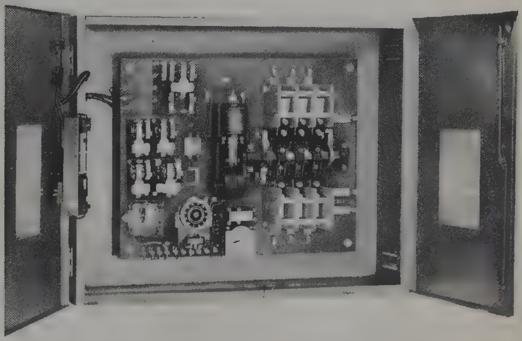
- Battery Charger ASCO Bulletin 203 for .... volts.
- Test button to simulate normal source failure.
- Plant exerciser to exercise plant under load every 168 hours. Exercise period shall be 15 minutes plus selected retransfer time.
- Auxiliary contact fused and connected to stand-by plant source for remote indicating light.
- Auxiliary contact fused and connected to normal source for remote indicating light.

The transfer switch with the specified accessories shall be enclosed in a NEMA 1 cabinet suitable for wall mounting. A complete circuit diagram shall be attached to the inside of the cabinet door.

WITH ANY EMERGENCY SOURCE... An automatic transfer switch shall be provided .... poles for a normal source of .... volts .... phase .... cycles and an emergency source of .... volts .... phase .... cycles to transfer the load circuits to the emergency source when any phase of the normal drops below 70%, and to automatically retransfer the load circuits to the normal source when all phases are 90% or more. An auxiliary contact shall close an indicating circuit when the load circuits are connected to the emergency source.

The transfer switch shall have adequate capacity for total load of .... amperes, consisting of approximately ....% tungsten lamp load and ....% motor and other loads.

Numerous accessory devices such as time delay against momentary outage, time delay on retransfer to normal, and others are considered indispensable in many applications. A list of accessories is included in all Bulletins; when using this specification please refer to ASCO Catalog 57-S1 for the necessary accessories.



ASCO Bulletin 905, 3 Pole, 150 Ampere Automatic Transfer Switch with full phase 70%-90% relay protection, 3 second time delay on momentary outage, adjustable time delay on retransfer to normal, 5 minute no-load running time for plant after retransfer, plant exerciser, and battery charger. Panel also includes charging disconnect relay to prevent overcharging of battery.

COMMON SPECIFICATIONS

The transfer switch shall be a double throw switch operated by a single coil mechanism momentarily energized. The switch shall be inherently interlocked mechanically and electrically. Operating current for transfer shall be obtained from the source to which the load is to be transferred. Failure of any coil or disarrangement of any part shall not permit a neutral position. The switch shall be positively locked mechanically on either source without use of hooks, latches, semi-permanent magnets or springs. Main contacts shall be silver surfaced, and protected by arcing contacts.

Switches rated for noninductive loads shall include arc barriers between poles, and shall be ASCO:
( ) Bulletin 905 type for (specify required rating)
( ) 30 ( ) 60 ( ) 150 ( ) 200 amperes.
( ) Bulletin 908 type for 100 amperes.
( ) Bulletin 907 type for (specify required rating)
( ) 300 ( ) 400 amperes.

Switches rated for inductive loads shall be equipped with magnetic blowouts and arc barriers on all poles, and shall be ASCO:
( ) Bulletin 906 type for (specify required rating)
( ) 100 ( ) 150 ( ) 200 ( ) 300 ( ) 400
( ) 600 ( ) 800 ( ) 1000 ( ) 1200 amperes.

The Automatic Switch Company offers its services in the preparation of suitable specifications for any application.

ASCO Electromagnetic Control ASCO

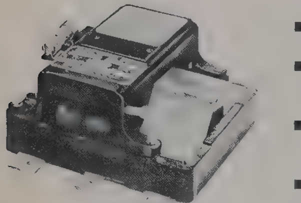
DEPENDABLE CONTROL BY Automatic Switch Co. 1000 HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • *AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL*

Tear this page at the perforations—keep it handy for ready reference. Reverse side shows typical specifications for Automatic Transfer Switches. For complete information, write for Publication 609 and Catalogs 57-S1 & 57-S2.

HOW TO SPECIFY REMOTE CONTROL SWITCHES

For lighting and mixed loads to 600 volts A-C, 250 volts D-C, 30-200 amperes . . .

Specify ASCO Bulletin 920 Remote Control Switches



CHARACTERISTICS:

- Rated in amperes per pole for noninductive load to 600 volts A-C and 250 volts D-C maximum.
- Sizes 30 to 200 amperes, 2 and 3 pole single throw.
- Suitable for tungsten lamp load, fluorescent and all other types of lighting loads.
- No derating when used on high inrush loads such as tungsten lamp load.
- Interrupting capacity 150% of rated current.
- Listed by Underwriters Laboratories for tungsten lamp load to full rating.

For Lighting and Mixed Loads to 250 Volts A-C, 30-400 Amperes, specify ASCO Bulletin 910

SUGGESTED SPECIFICATIONS

1. The Remote Control Switches shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches or semi-permanent magnets. Control stations shall be required to make but not break the operating coil current.

2. Main contacts shall be double break silver to silver type protected by arcing contacts. Contacts shall be self-aligning and renewable from the front of the panel.

3. Control connections shall be clearly marked "L" for line wire, "C" for closing wire, and "O" for opening wire. A manual operating lever shall be included.

4. Switches shall be Underwriters' Laboratories listed at full load rating for use with gas-filled tungsten filament lamps, and shall be the approved equal of the Automatic Switch Company "Type RC" Bulletin 920 Remote Control Switch.

For small panelboards . . .

Specify ASCO Bulletin 909 Remote Control Switches

CHARACTERISTICS:

- Rated 30 amperes per pole for non-inductive load to 250 volts A-C and 125 volts D-C.
- Suitable for tungsten lamp load, fluorescent and all other types of lighting loads.
- Interrupting capacity 150% of rated current.
- Double break contacts.

SUGGESTED SPECIFICATIONS

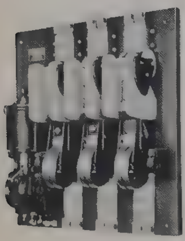
1. The Remote Control Switches shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches or semi-permanent magnets. Control stations shall be required to make but not break the operating coil current.

2. Main contacts shall be double break silver alloy and shall be self-aligning and renewable from the front of the panel.

3. Switches shall be the approved equal of Automatic Switch Company Bulletin 909, 250 volts, 30 amperes full rating for non-inductive load and for gas-filled tungsten filament lamp load.

For high capacity, highly inductive loads . . .

Specify ASCO Bulletin 911 Remote Control Switches



CHARACTERISTICS:

- Rated in amperes per pole for all classes of load A-C or D-C.
- Standard listing in capacities from 30 to 1000 amperes to 600 volts A-C and 250 volts D-C.
- Available to 750 volts A-C or D-C.
- Current coil type magnetic blowout on each pole.
- Interrupting capacity to 15 times rated current.
- Thermal capacity not less than 20 times rated current.
- No derating regardless of class of load.

SUGGESTED SPECIFICATIONS

1. The Remote Control Switches shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches or semi-permanent magnets. Control stations shall be required to make but not break the operating coil current.

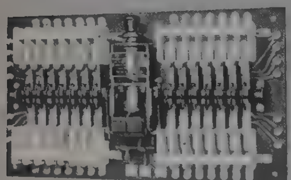
2. Main contacts shall be silver surfaced and shall be protected by arcing contacts and magnetic blowouts with arc barriers. Contacts shall be renewable from the front of the panel.

3. Control terminals shall be clearly marked "L" for line wire, "C" for closing wire, and "O" for opening wire. A manual operating lever shall be included.

4. Switches shall be suitable for all classes of load to full rating and shall be the approved equal of ASCO Bulletin 911 Remote Control Switches.

For multi-pole requirements . . .

Specify ASCO Bulletin 915 Remote Control Switches



CHARACTERISTICS:

- Up to 24 poles double throw.
- Rated in amperes per pole for non-inductive load to 250 volts A-C.
- Standard listing in capacity of 30 amperes. Available to 100 amps.
- Suitable for tungsten lamp load, fluorescent and all other types of lighting loads.
- Interrupting capacity 150% of rated current.
- Barriers between poles.

SUGGESTED SPECIFICATIONS

1. The Remote Control Switches shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches or semi-permanent magnets. Control stations shall be required to make but not break the operating coil current.

2. Main contacts shall be silver alloy with adequate opposite polarity spacing between poles. All poles shall be protected by arc barriers. Contacts shall be self-aligning and renewable from the front of the panel.

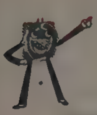
3. Control terminals shall be clearly marked "L" for line wire, "C" for closing wire, and "O" for opening wire. A manual operating lever shall be included.

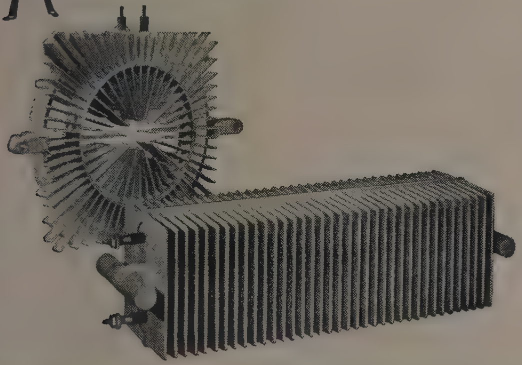
4. Switches shall be suitable for use up to full rating on gas-filled tungsten lamp load and other non-inductive loads, and shall be the approved equal of ASCO Bulletin 915 Remote Control Switches.

ASCO Electromagnetic Control ASCO.

DEPENDABLE CONTROL BY Automatic Switch Co. 10000 HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • *AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL*

SAFETY GRID...one big reason why Electromode meets your heating needs best





This is the cast-aluminum Safety Grid that places Electromode electric heaters among the world's best performers. It makes Electromode an unusual heating value.

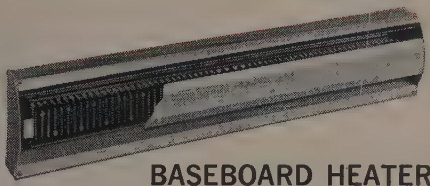
It's extremely efficient. It can maintain high heat output at a low surface temperature because of its large heating surface.

It's safe. A built-in safety switch automatically prevents overheating and cuts heater off if anything should interfere with normal operation.

It's an added value you'll find in all of the Electromode heaters shown here except the Quartzone heater and the explosion-proof heater.

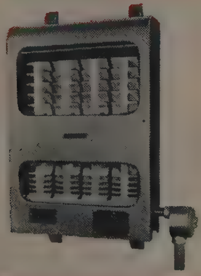
SUSPENSION HEATER

Installs easily—no plumbing or duct work necessary. Capacities from 5,122 to 153,675 BTU. 120, 208, 240 or 480 volts.



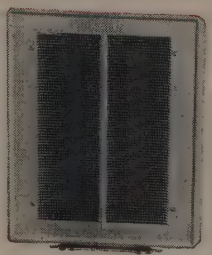
BASEBOARD HEATER

Lengths of 32", 64", and 96" for easy installation, flexible arrangement. Matching fittings. Golden-bronze finish. 120, 208 or 240 volts.



EXPLOSION-PROOF HEATER

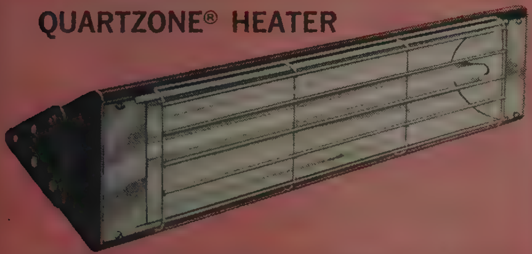
Outputs of 3,413 to 20,490 BTU for hazardous atmosphere. Also panel model of 1,706 BTU for ethyl ether vapor atmosphere. 120, 208, 240 or 480 volts.



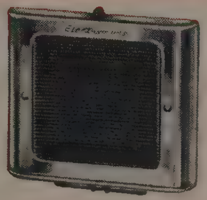
DOWN-FLO HEATER

Built-in wall heater. Thermostat, fan delay switch, down-flo principle. Golden-bronze finish. 5,122 to 13,660 BTU. 120, 208 or 240 volts.

QUARTZONE® HEATER



Infrared rays heat persons and objects, not just air. Removable aluminum reflector. 750, 1000, 1500, 2000, 3000 or 4000 watts. 120, 208, 240 or 480 volts.



BATHROOM HEATER

Easily installed. Automatic or switch operated. Safety Grid protects against shock or burn. 4,507 or 5,122 BTU. 110, 208 or 240 volts.

● FOR DETAILED INFORMATION, PRICES, AND INSTALLATION INSTRUCTIONS, WRITE:

Dept. ECM-51

®**Electromode**

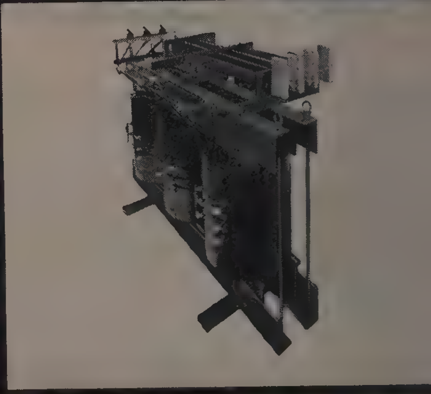
DIVISION OF COMMERCIAL CONTROLS
CORPORATION, 570 CULVER ROAD, ROCHESTER 3, N. Y.

Shown discussing the customer merits of a newly installed 112½ KVA Sorgel Dry-Type Transformer are Mr. Richard R. Pooley, Facilities Manager of Tektronix, Inc.; Mr. Jerry Jones, General Superintendent, W. R. Grasle Company, Electrical Contractors, Portland, Oregon; and Sorgel Sales Engineer, Mr. Henry C. Lehl. This transformer is installed in Tektronix's main facilities at Beaverton, Oregon. The Contractor commented on the fast installation of Sorgel units because of knockouts on all sides and easy accessibility to terminal connections.

**1/4 KVA
TO
10,000 KVA,
ALL STANDARD
AND
INTERMEDIATE
VOLTAGES
UP TO
15,000
VOLTS**

SORGEL HAS A DRY-TYP

Popular sizes up to 75 KVA, both single and 3 phase transformers, are normally in factory stock. They are also constructed to be interchangeable for wall or floor mounting.



The transformer is the heart of your er electrical system. Here is where true qua gives you dependability and low cost op tion. Illustrated is a 500 KVA, 5 KV class,f Sorgel unit substation.

If you BUY, SPECIFY or INSTALL transformers, YOU SHOULD KNOW THESE IMPORTANT FACTS

Here Are Eight Sorgel Customer Benefits That Mean Positive Savings in Dollars

These engineered advantages show why Sorgel dry-type transformers are considered the finest in the electrical field. These quality features, and many others, assure you of economy in installation and operation.

- All coils have end filler protection in each layer to prevent movement of conductors under heavy loads and short circuit stress conditions.
- The transformer core and coil unit is specifically designed for low sound level. In units 15 KVA and larger, the core and coils are mounted on vibration dampening pads designed to suppress transmission of vibration to adjacent areas.
- Each unit is completely assembled, wired, and tested at the factory, ready for line and load connections eliminating any job-site assembly.
- All terminations are securely anchored, and solderless connectors are furnished on all transformers with terminal boards. Vacuum impregnated windings are brazed to the terminals.
- Connection covers are cushioned and easily removed by means of two captive bolts on small sizes, and four on larger sizes.
- Ventilating openings are designed to prevent accidental access to live terminal parts. Expanded metal is not used on sides, back or front.
- In Quiet-Quality units, performance data, such as core loss, copper loss, sound level, etc., is always equal to, or lower than, the guaranteed values submitted to the customer.
- Sorgel units are individually tested in accordance with NEMA standards. Certified tests are furnished upon request, to further substantiate the guaranteed data.

Contact your nearest Sorgel Sales Engineer for additional reasons why Sorgel units are truly your most economical buy - as quality pays, it doesn't cost.

SORGEL
SOUND-RATED DRY-TYPE
TRANSFORMERS

SORGEL ELECTRIC COMPANY
Since 1916 the pioneer in the development, manufacturing
and application of sound-rated dry-type transformers
836 WEST NATIONAL AVENUE • MILWAUKEE 4, MIS.
Experienced sales engineers in principal cities

TRANSFORMER FOR YOUR EVERY NEED

All units are built to meet or exceed latest standards of ASA, NEMA and AIEE. Sorgel provides the most liberal designs and a co-ordinated system of either Class B, F or H insulation with the most effective use of quality materials to assure continuity of service.

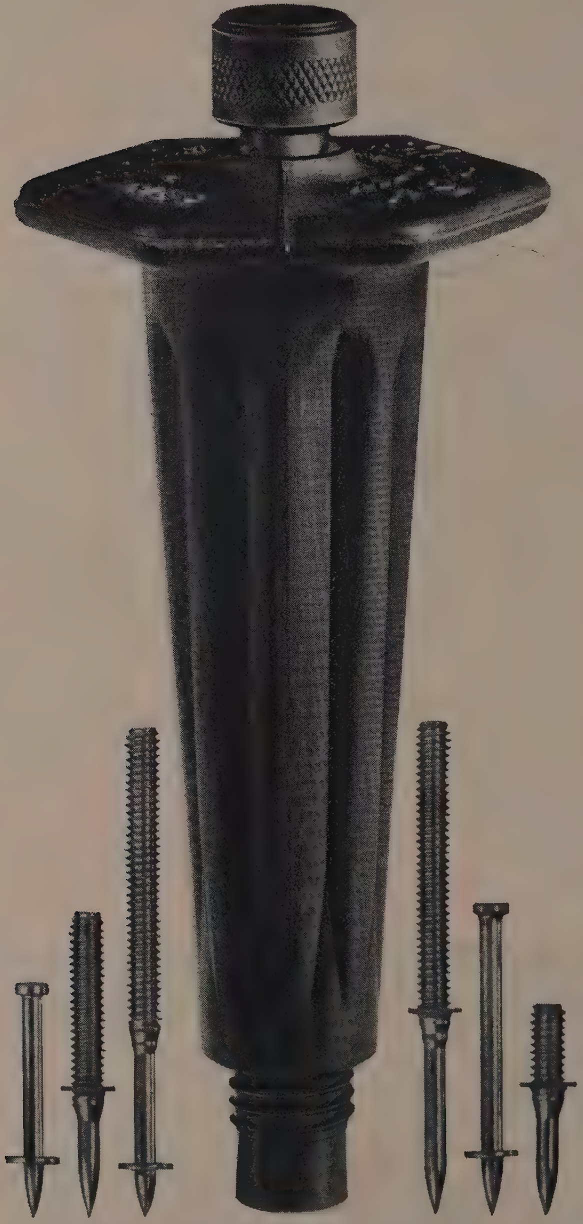
Every Sorgel product is carefully packaged to provide maximum shipping protection and ease of handling. Pallet mounting and easy-to-use lifting eyes on sizes 2 KVA and larger really mean fast installations.

CLIP AND MAIL FOR TECHNICAL BULLETINS.

☐ 611—Transformer Line
☐ 960—Substations
☐ 658—DC Saturable Reactors

Name________________
Title________________
Address________________
City________________
State________________

So Simple



It's a wonder nobody thought of it sooner

This is Shure-Set,® the tool that makes permanent attachments to concrete or building block with less than ten taps of a hammer. And it's about as easy to use as the hammer. Special steel fasteners are inserted at one end, your hammer strikes the other. And that's all, the fastening is made. (No powder charges are necessary.)

There's no drilling or plugging to do. And none of the problems associated with masonry nails. Shure-Set's anvil, an easy target to hit, concentrates the force of your hammer blow and applies it directly to the head of the fastener inside Shure-Set's precision bore. That way the hammer never skews off and the fastener never wavers. (Your fingers are well protected, t

And the austempered steel fasteners (nail-like drive pins threaded studs) can't bend or break or fly around the room; t have the ideal metallurgical characteristics for efficiently penetrat hard construction materials.

Shure-Set will pay for itself by saving time. Probably on the v first job. It also saves a lot of (put your own price on it) perspirati It's made by Ramset Fastening System. Write for more informati or call your local Ramset dealer. He's lis under "Tools" in The Yellow Pages.

Ramset® Fastening System

WINCHESTER-WESTERN DIVISION **Olin** 285-E Winchester Ave., New Haven 4, Conn.

Ilgjet UA-205 Fly Fans guarding entrance and exit doors in supermarket.

IT'S
HIGH
TIME
YOU
THOUGHT
ABOUT

TIME

ILG fans blast flies

Flies can't enter when Ilg fly fans guard doorways. Whether you prefer an Ilg centrifugal or a propeller fly fan, you can be sure that the Ilg propelled powerful curtain of moving air will blast flies and other insects away.

For more complete details on Ilg fly fans, clip and mail the coupon.

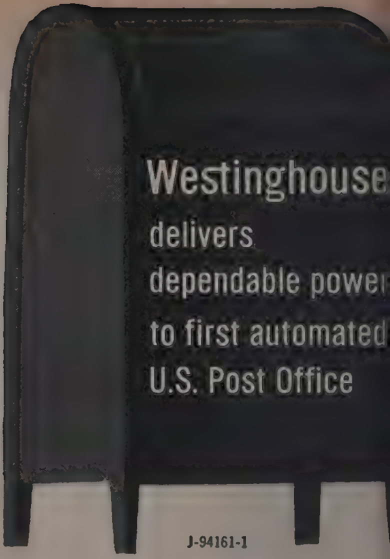
ILG ILG ELECTRIC VENTILATING CO.
2879 N. Pulaski Road, Chicago 41, Ill.
Offices in 60 Principal Cities
Member of Air Moving and Conditioning Association, Inc. (AMCA)

Ilg Electric Ventilating Co.
2879 N. Pulaski Road
Chicago 41, Illinois

☐ Send bulletin on UA-205 and B-15FF fly fans.

☐ Have a representative call me.

Name____________________
Title____________________
Company____________________
Address____________________
City__________Zone____State________



Westinghouse delivers dependable powe to first automated U.S. Post Office

(Below) Functional, clean lines of the Providence Post Office exterior are highlighted by Westinghouse OV-25 parking area luminaires, assuring 24-hour maximum security operation. The luminaires' horizontal housing and tilted optical system are completely sealed against dirt, moisture and bugs for years of low maintenance, high efficiency operation.

nation's first automated post office, labeled
ject Turnkey," is operating now in Provi-
e, R.I. It represents the first step in the
rnment's plan to make the complexity of
handling completely automatic to insure 24-
delivery of mail to any part of the country.
ehind the architectural beauty of this
000,000 facility is a vital electrical nervous
em. And it's the sure, steady performance
estinghouse electrical apparatus that keeps
marvel humming.
rom dependable, maintenance-free outdoor
naires that light the 14-acre site to 69 power
lighting panelboards that feed sensitive
r sorters, facing and cancelling machines,
el post machine and conveyor system, West-
ouse products coordinate for the high degree

(*continued on next page*)

These 11 sorters distribute mail to bins for 300 separate destinations after an operator's key punch code has sent an impulse to the memory unit of the sorter. Other major machines in the system are six letter cullers, six facer-cancellers, two parcel post sorters, and over three miles of conveyors.

Owner: Intelex Systems, Inc. Architect-Engineers: Charles A. Maguire and Associates, Providence, R.I. General Contractor: Gilbane Building Company, Providence, R.I. Electrical Contractor: Brady Electrical Company, East Providence, R.I. Westinghouse Distributor: WESCO, Providence, R.I.

(continued from preceding pages)

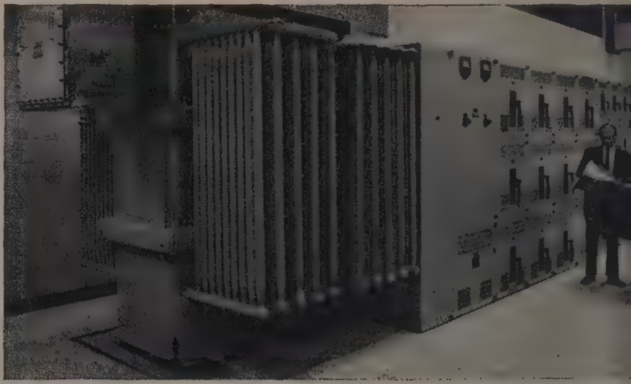
of service so important to this "Post Office of Tomorrow." It is estimated that 10,250,000 kilowatt hours of electrical energy will be required annually for the 24-hour operation of the plant.

The Gilbane Building Company, Providence, erected the structure for Intelex, a subsidiary of International Telephone & Telegraph, who will lease it and its mechanized mail processing equipment to the government for 20 years. Design was by Charles A. Maguire and Associates, Providence. Westinghouse personnel worked closely with the consulting engineer from design stages through completion. Experience and the completeness of the Westinghouse line earned this working role in mail handling history.

You can be *sure* . . . if it's Westinghouse!

(Below) Reviewing drawings during the construction of Project Turnkey are, left to right: Arthur A. Watson, General Foreman, Brady Electrical Co., Inc.; A. I. Israel, Charles A. Maguire and Associates; E. Howard Rohrbach, Project Manager, Intelex Systems; Richard F. Martin, Project Manager, Gilbane Building Company; R. W. MacArthur, Westinghouse; and Walter W. Botts, Manager WESCO, Providence.

(Above) Rugged, weatherproof enclosure shields Westinghouse 150-DH
air circuit breakers which protect main feeders providing power to the
office. Inspecting breakers are A. A. Watson, W. W. Botts, R. W. MacAr
and A. I. Israel (kneeling).



This main substation, rated 2500 kva, provides reliable source for lighting
power circuits. It receives incoming power at 11 kv directly from outdoor r
clad switchgear. Discussing schematic drawings of power circuits are: A. I. Is
A. A. Watson and R. McCloskey, Resident Engineer, Charles A. Maguire
Associates.

ove) A. I. Israel operates remote circuit
aker control panel for 15 kv outdoor metal
d switchgear as R. W. MacArthur looks
Switchgear furnishes incoming power
ely and efficiently to Westinghouse 500
power center serving post office auxil-
es. Compact design permitted location
ninimum space, freeing valuable footage
work areas.

A. I. Israel, left, and W. W. Botts discuss operation of electrical system in mechanical building. In foreground is a 60 hp, 208 volt drip-proof Westinghouse motor, driving a chilled water pump. 400 amp safety switch on wall feeds an autotransformer reduced voltage starter which cushions inrush current to assure smooth pump start-up.

Westinghouse CDP power distribution panelboards equipped with De-ion® circuit breakers control and protect feeder circuits supplying power to intricate mail handling equipment. Complex systematized handling system requires reliable power supply since local failures would seriously impair movement schedules. Famed De-ion principle of arc quenching assures maximum circuit breaker life by preventing burning and pitting contacts.

Westinghouse

161-2

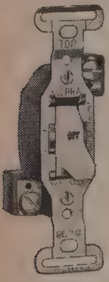
For that certain kind of contractor who demands the best...

Sierra®
WIRING DEVICES

SWITCHES

SILENT MERCURY

No moving springs or blades to fail. Each switch load-tested.


5001

5002

5003

5004

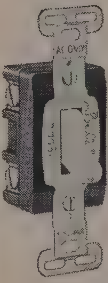
QuieT SWITCH

Combines effortless toggle action with positive current control.

5011

5012

5013


5014

SAVE THIS HANDY

SELECTOR GUIDE

for Specification Grade devices

DESCRIPTION	SILENT MERCURY SWITCHES IVORY	SILENT MERCURY SWITCHES BROWN	QuieT SWITCHES* 15 AMP IVORY	QuieT SWITCHES* 15 AMP BROWN	QuieT SWITCHES* 20 AMP IVORY	QuieT SWITCHES* 20 AMP BROWN
Single Pole	5001	5001X	5011	5011X	5051	5051X
Double Pole	5002	5002X	5012	5012X	5052	5052X
Three-Way	5003	5003X	5013	5013X	5053	5053X
Four-Way	5004	5004X	5014	5014X	5054	5054X
Sierra-Lite with glowing toggle						
Single Pole	5005	—	—	—	—	—
Three-Way	5006	—	—	—	—	—

RATINGS

125V "T"	250V	120V, AC
10A	5A	15A

RATINGS

120—277V, AC

*Key operated types also available

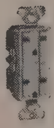
RECEPTACLES

SIERRAPLEX

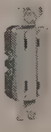
First major design improvement in years! These distinctively styled receptacles are complemented by a full line of matching wall plates. Specification Grade. Meet all existing codes and standards.

1800

1600

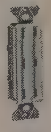

1801

1601


1700

1500

1850


1900

DESCRIPTION	PARALLEL SLOTS 15A-125V IVORY	PARALLEL SLOTS 15A-125V BROWN	TANDEM SLOTS 15A-250V IVORY	TANDEM SLOTS 15A-250V BROWN
BACK AND SIDE WIRED				
Single Grounding-Type 3-wire	1600	1600X	1601	1601X
Duplex Grounding-Type 3-wire	1800	1800X	1801	1801X
Comb. Duplex Grdg-Type 3-wire 15A 125V-250V			1850	1850X
Single Convenience 2-wire	1500	1500X	—	—
Duplex Convenience 2-wire	1700	1700X	—	—
SIDE WIRED				
Single Grounding-Type 3-wire	1602	1602X	1603	1603X
Duplex Grounding-Type 3-wire	1802	1802X	1803	1803X
Comb. Duplex Grdg-Type 3-wire 15A 125V-250V			1852	1852X
Single Convenience 2-wire	1502	1502X	—	—
Duplex Convenience 2-wire	1702	1702X	—	—
Triplex—Single Circuit	1900	1900X	—	—
Triplex—2 Feeds—1 Return	1901	1901X	—	—
Triplex—2 Feeds—2 Returns	1902	1902X	—	—

SIERRA

Conventionally styled, this popular line offers same high quality and craftsmanship as Sierraplex. Features include 2 grounding screws on 3-wire types, handy wire strip gage, and break-off strip for 2 circuits.

1400

1200

1401

1201

1300

1100

1450

DESCRIPTION	PARALLEL SLOTS 15A-125V IVORY	PARALLEL SLOTS 15A-125V BROWN	TANDEM SLOTS 15A-250V IVORY	TANDEM SLOTS 15A-250V BROWN
BACK AND SIDE WIRED				
Single Grounding-Type 3-wire	1200	1200X	1201	1201X
Duplex Grounding-Type 3-wire	1400	1400X	1401	1401X
Comb. Duplex Grdg-Type 3-wire 15A 125V-250V			1450	1450X
Single Convenience 2-wire	1100	1100X	—	—
Duplex Convenience 2-wire	1300	1300X	—	—
SIDE WIRED				
Single Grounding-Type 3-wire	1202	1202X	1203	1203X
Duplex Grounding-Type 3-wire	1402	1402X	1403	1403X
Comb. Duplex Grdg-Type 3-wire 15A 125V-250V			1452	1452X
Single Convenience 2-wire	1102	1102X	—	—
Duplex Convenience 2-wire	1302	1302X	—	—

WALL PLATES

Choose from world's most complete line! Over 5000 wall plates in Plastic, Brass and Stainless Steel; and in a variety of styles, colors, finishes, combinations and gangs.

STAINLESS "S" LINE

BRASS "B" LINE

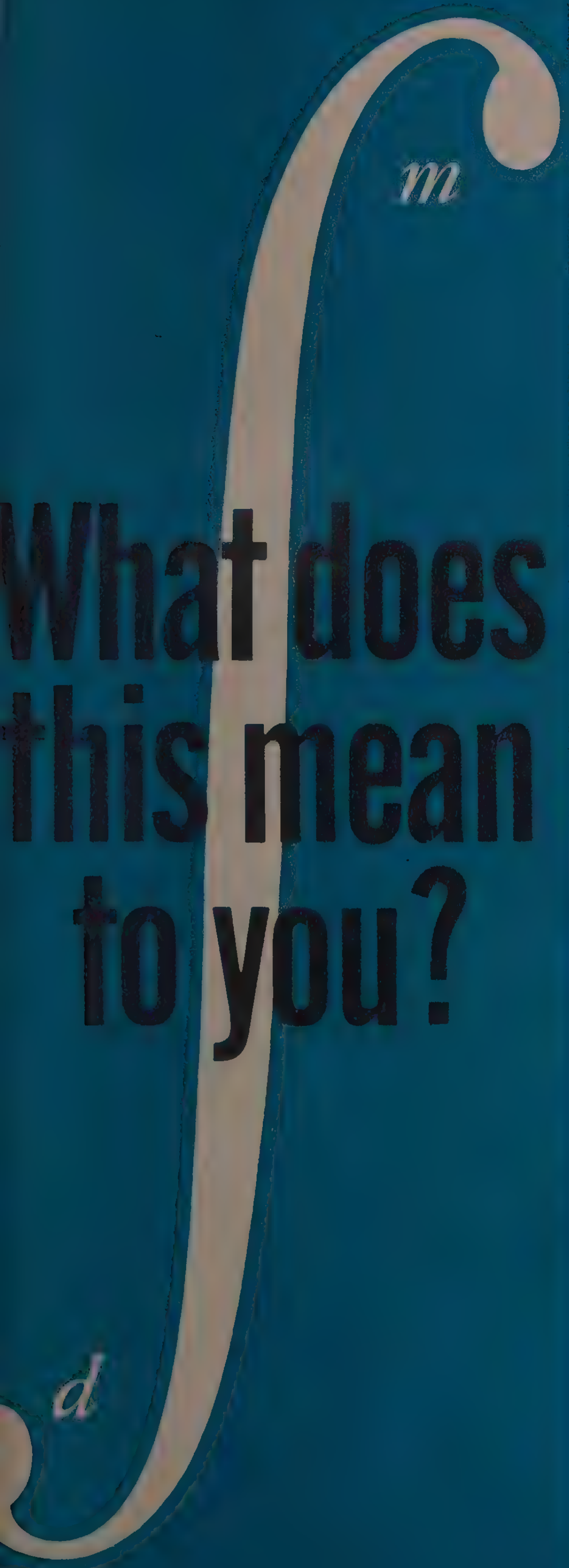
PLASTIC "P" LINE

PLASTIC "D" LINE

Write for catalog

SIERRA ELECTRIC CORPORATION
15100 S. Figueroa Street
Box 85, Gardena, California

Leadership through craftsmanship



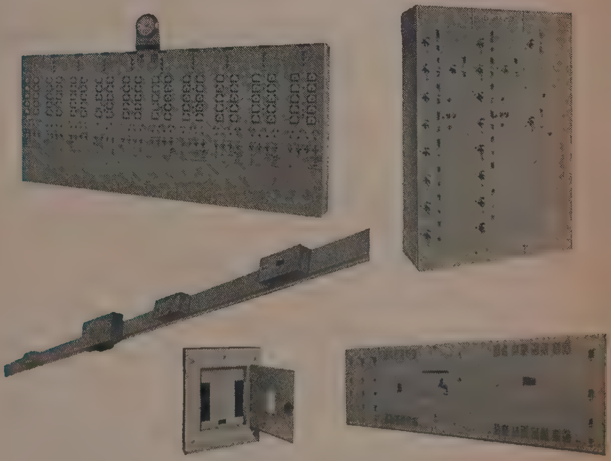
What does this mean to you?

At CONTINENTAL

Electric Equipment Co. this symbol means the integration of design and manufacturing abilities to produce electrical distribution and control equipment that is second to none. Through Continental flexibility we provide broadest recognition of your engineering expression. A proprietary manufacturer of electrical equipment, Continental can also incorporate instruments and control components of other manufacture into your system design.

Proprietary Manufacturer of Electrical Distribution and Control Systems

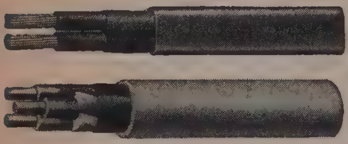
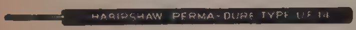
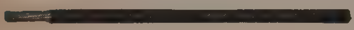
Unit Substations
Switchgear
Bus Duct and Plugs
Panel Boards
Control Consoles
Safety Switches
Motor Control Centers
Special Instrument Boards
Missile and Aero-Space Control Centers



For more information, please write

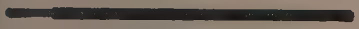
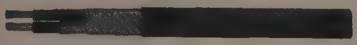
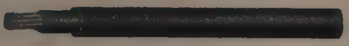
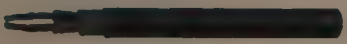
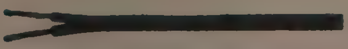
CONTINENTAL
ELECTRIC EQUIPMENT COMPANY
Box 1055, Cincinnati 1, Ohio
Plants at: Ludlow, Ky. • Wilder, Ky.

Index of Phelps Dodge

Wires and Cables	*Type Letter*	*Trade Name or Designation*	*Maximum Operating Temperature*	*USE*
	ACV	Armo-Lok	85 C (185 F)	Dry Locations
	None	Armo-Lok	85 C (185 F) High Voltage	General Purpose: Consult manufacturer for specific applications
	W	Portable Power Cable	75 C (167 F)	Mining Machines, Dredges, Shovels, and similar portable applications Pennsylvania Dept. of Mines Flame Resistance Approval P-114. U. S. Bureau of Mines Listing P-114-BM.
	G		Low Voltage	
	SHD		85 C (185 F) High Voltage	
	RHW	Flamestop Heat and Moisture Resistant	75 C (167 F)	Dry and Wet Locations
	RHH	Flamestop Heat-Resistant	90 C (194 F)	Dry Locations
	**RHL**	Heat Resistant Rubber Lead	75 C (167 F)	Wet Locations and other Special Conditions
	NM	PD-X Nonmetallic-Sheathed Cable	60 C (140 F)	For Wiring Houses, Rural Buildings, Small Stores, and Shops.
	**UF**	Perma-Dure Nonmetallic-Sheathed Cable	60 C (140 F)	UF: Underground Feeder and Branch Circuit Cable for Direct Burial.
	UF-NMC			NMC: For Interior Wiring in Moist or Corrosive Locations.
	THW	Habirdure Thermoplastic insulated	75 C (167 F)	Dry and Wet Locations
	TW		60 C (140 F)	Dry and Wet Locations
	**TF**		60 C (140 F)	Fixture Wire
	None	Petro-Dure Thermoplastic Insulated Nylon Jacketed	60 C (140 F)	Moist locations and where exposed to mineral oil, liquid gasoline and gasoline vapor.
	None	Habirdure Machine Tool, Control, and Switchboard Wire	90 C (194 F) in air 80 C (176 F) in oil	Machine Tool, Control and Switchboard Wiring

PHELPS DODGE COPPER PRODUCTS CORPORATION

Wires and Cables

Wires and Cables	*Type Letter*	*Trade Name or Designation*	*Maximum Operating Temperature*	*USE*
	**TW**	Habirdure (9T)	60 C as TW 90 C as Appliance Wiring	NEC Type TW Bldg. Wire—60°C Appliance Wiring—90°C in air or 60°C in water or oil
	None	Habirdure Appliance Wire	105 C (221 F) IN AIR 80 C (176 F) IN OIL	Appliance Wiring
	SE	Service Entrance Type SE — Style U Unarmored	75 C (167 F)	Service Entrance or Combination Service Drop & Service Entrance
	**SD**	Service Drop Type SD	60 C (140 F)	Service Drop
 	USE	Service Entrance Type USE	75 C (167 F)	Underground Service Entrance, Direct Burial.
	V	Varnished Cloth Braided	85 C (185 F)	Dry locations only. Smaller than No. 6 by special permission.
	VL	Varnished Cloth Lead	85 C (185 F)	Wet or Dry locations. Smaller than No. 6 by special permission.
 	**None**	Habirduct Habirprene	75 C (167 F) Low Voltage	General Purpose for Direct Burial, Aerial, Conduit and Underground Duct Installations.
		Habirite Habirprene	85 C (185 F) High Voltage	
	S or SO	Hard Service Cord	60 C (140 F)	Pendant or portable extra hard usage in damp locations; SO for oil resistance
	**SJ or SJO**	Junior Hard Service Cord	60 C (140 F)	Pendant or portable hard usage in damp locations; SJO for oil resistance
	**SP**	All Rubber Parallel Cord	60 C (140 F)	For use in pendant or portable applications in damp locations not subject to hard usage

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—|———|—

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Copper Conductors
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BULLETIN AB-760 deals with LO-X® Duct for heavy feeders and BD Plug-In Duct for distribution—both with aluminum conductors.

BULLETIN CB-755 provides similar data on LO-X Duct and BD Plug-In Duct with copper conductors.

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Sales Manager—Duct Systems
Box 177
Detroit 32, Michigan

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I-T-E CIRCUIT BREAKER COMPANY
BULLDOG ELECTRIC PRODUCTS DIVISION

60TH YEAR • MAY, 1961

ELECTRICAL
CONSTRUCTION
AND MAINTENANCE

For Better Specifications

Identifying the most earnestly studied literature of the electrical contruction field is easy. The familiar job specification ranks in a class by itself. From preliminary estimate to final payment it is the object of critical study and constant reference in every area of construction.

The language of specifications is lean and imperative, as it must be, to convey accurate and compelling instructions to all concerned. It must be so clear and consistent as to leave no doubt about its literal meaning and intent by all who may need its guidance.

Specification writing is not limited solely to formal contract documents. It is a widely useful method of precise communication for the description of all types of electrical work, actual or proposed. It also provides mutually acceptable conditions, limitations and details for recommendations and proposals.

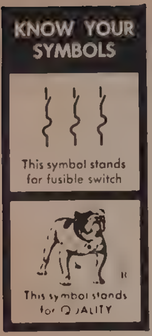
A guide and reference to specification preparation is a useful and often essential aid for those who must write specifications and for those who must understand and interpret them. The master electrical specification, to which most of the editorial pages of this issue is devoted, is a unique project originated by this publication and regularly revised and brought up-to-date every three years. It is designed to provide immediately useful and practical help for everyone concerned with the writing of electrical job specifications, communications, proposals or recommendations.

The project is arranged in eleven sections in an order common in formal project specifications. A handy check list in each section can be used to check specifications for completeness or omissions and also provides a guide to the section contents. The text follows two styles: instruction and data regarding the preparation of specifications appear in light face type; actual prototype or typical specification paragraphs appear in bold face type.

As an industry reference work, this specification avoids bias or preference for particular products or methods. Specifics which appear necessarily in typical specification paragraphs are illustrative of details only and are not intended to exclude other considerations. It is expected that the user will modify and enhance the material presented to meet his own particular preferences. And practical specifications will, of course, require the naming of preferred makes and catalog numbers.

The importance of accurate, comprehensive and clear electrical specifications is well known. The thousands of products, parts and components that make up electrical systems and the methods and workmanship with which they are installed require expert selection and direction if desired quality and performance is to be achieved. It is our hope that this master electrical specification will prove a useful tool in the cause of better specification practice.

Wm. T. Stuart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1.0 General Conditions

CHECK LIST

- ☐ **Bids, Contract and Schedules**
- ☐ **Bonds** — performance
- ☐ **Changes** — plans and specifications
- ☐ **Cutting, Patching and Repairs**
- ☐ **Definitions** — contract and specification terms
- ☐ **Description of the project**
- ☐ **Drawings** — working, shop
- ☐ **Electrical Work,** scope of
  - — in this contract
  - — not included in contract
  - — by others
- ☐ **Examination of Site and Other Drawings**
- ☐ **Field Office and Storage Areas**
- ☐ **Guarantee**
- ☐ **Inspections**
- ☐ **Insurance,** Indemnity
- ☐ **Interference with Other Trades**
- ☐ **Labor and Supervision**
- ☐ **Licenses, Permits, Fees, Taxes**
- ☐ **Materials** — type and quality
  - — furnished and installed by this contractor
  - — furnished by others but installed by this contractor
  - — furnished and installed by others, but connected by this contractor
- ☐ **Payments** — when, how made and on what basis
- ☐ **Protection** — to life and property, watchman, etc.
- ☐ **Removal of Rubbish,** etc.
- ☐ **Rules and Regulations** — codes, ordinances, etc.
- ☐ **Safety**
- ☐ **Signs** — protective, advertising, etc.
- ☐ **Sleeves, Slots, Chases and Openings**
- ☐ **Specifications** — intent and precedence
- ☐ **Substations** — material and equipment, how handled
- ☐ **Temporary Facilities** — light, heat, power, water
  - — who is to supply and pay for each
- ☐ **Temporary Work**
- ☐ **Termination of Work**
- ☐ **Other Items** dictated by specific project

General Conditions of a specification refer to the project as a whole, and apply to all contractors and suppliers involved in the work. Certain considerations, such as scope of the work, must be tailored to the specific installation described by the rest of the specification that follows.

Such specialized conditions relevant only to the electrical work could be handled as Supplementary General Conditions appearing in the electrical section. These would supplement conditions applying to all subdivisions of the project specifications.

Depending upon size, type and complexity of the project, these conditions may consist of a few paragraphs or may include numbers of pages giving detailed instructions to the bidders and installing contractors.

General Conditions covering a specific project could be amplified in accordance with the following outline:

1.1 Defining the Project

1.11 General description of the property, building layout, construction, height, type of occupancy, boundary lines, address and similar descriptive material.

1.12 Scope of the work; listing all systems that are to be included in the contract and which will be discussed in detail in subsequent sections of the specifications. This section should also spell out what electrical work is not included in the contract; what electrical equipment items are to be furnished by others, but installed by this contractor; what electrical equipment is to be furnished and installed by others, but connected by this contractor.

1.13 Drawings related to the specifications; which ones are to be considered "working drawings"; instructions relating to "shop drawings" to be supplied by the contractor and equipment suppliers; addition to plans of changes dictated by local conditions and encountered during installation. Some specifications also direct the contractor to submit a final set of corrected "as installed" drawings upon completion of the work.

1.14 Symbols and abbreviations.

1.15 Definition of terms.

1.16 Addenda, revisions, alternates.

1.17 Examination of the site to eliminate misconceptions of fact and to verify dimensions, available utility services, topographical features, transportation provisions, storage facilities.

1.18 Surveys for datum planes, elevations, benchmarks and stakes; how to request and by whom to be made.

1.19 Order of precedence—specifications, plans, drawings, etc.

1.20 Examination of drawings of other trades and systems for checking.

1.2 Bids and Schedules

1.21 Method of submitting bids; to whom, when, in what form, and with what alternates.

1.22 Time schedules, work program, layout of work.

1.23 Inspection, supervision, approvals.

1.24 Extra work—explain the procedure for authorization, estimate and adjustment of desired additional work not covered in the original specifications.

1.3 Governing Conditions

1.31 Codes, regulations, safety orders, building laws and ordinances, such as the National Electrical Code, American Institute of Architects' contract for construction of buildings, State Industrial Accident Commission orders, plus any other national, state, municipal, utility or company directives relating to the contemplated type of work.

1.32 Code rulings and interpretations; by whom rendered in event of question.

1.33 Precedence of design features outlined in specifications and drawings, if they are over and above requirements of relevant Codes.

1.34 Arbitration of errors or conflicts—how handled.

1.35 Responsibility, status and definition of owner, architect, engineer and contractor.

1.4 Financial Consideration

1.41 Insurance coverage for fire, theft, public liability, workman's compensation.

1.42 Bond for evidence of financial responsibility.

1.43 Local fees related to securing all required permits, certificates.

1.44 Method of payment, governed by either prefixed dates, progress reports, progress photographs, payroll, bills of materials; retained percentages; final payment.

1.45 Withholding Social Security deductions from payroll of workers.

1.46 Liens.

1.47 Responsibility for taxes.

1.5 Protection

1.51 Physical precautions related to protection of materials, tools, equipment, working personnel, public.

1.52 Enclosed storage areas, tool cribs, work sheds, field offices, general headquarters.

1.53 Provision for watchman service, fire extinguishers.

1.54 Guard rails around excavations or elevated work areas, padlocks on enclosures, notices and warnings pertaining to high voltage, protective guards on power saws, drills and similar tools.

1.55 Approved tools, appliances, devices, scaffolds and hoisting equipment for use during construction.

1.6 Materials

1.61 Required standards, labels, approvals, tests, samples.

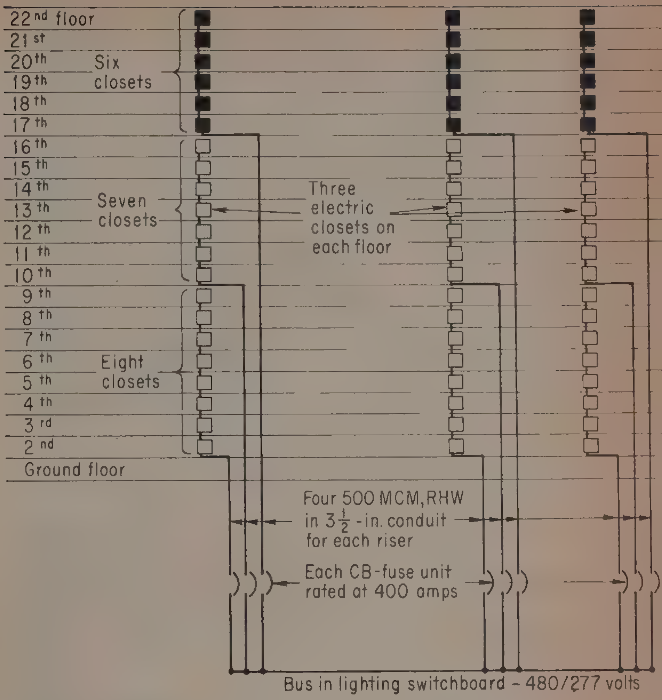
1.62 Specification by manufacturer, brand name and catalog number—intent; meaning of "or approved equal" clauses.

1.63 Substitution of material or equipment items for those specified—on what basis and when permitted; procedure to follow.

1.64 Quality of related hardware on the job.

1.65 Causes for rejection of materials or equipment.

1.66 Gauges of metal used in enclosures and boxes; wire and cable sizes.


22nd floor
21st
20th
19th
18th
17th
16th
15th
14th
13th
12th
11th
10th
9th
8th
7th
6th
5th
4th
3rd
2nd
Ground floor
Six closets
Seven closets
Eight closets
Three electric closets on each floor
Four 500 MCM, RHW in 3½-in. conduit for each riser
Each CB-fuse unit rated at 400 amps
Bus in lighting switchboard – 480/277 volts

SIMPLE RISER diagram for high-rise building helps interpret distribution concept; facilitates take-off, estimating; and expedites installation.

1.67 Point of delivery on job site of material and equipment; on what dates.

1.68 Movement of material and equipment from job site delivery point to installation point—by whom; how protected against theft, damage or deterioration.

1.7 Labor

1.71 Governing labor laws, prevailing or acceptable wage scales to be followed.

1.72 Specifications of labor force, such as skill of mechanics, supervision ratio of foremen to journeymen to apprentices, etc.

1.73 Clauses relating to anti-discrimination, preference to handicapped workers or veterans, seniority and similar factors where applicable.

1.74 Reasons for dismissal.

1.8 Approvals

1.81 Claims for extensions of deadlines, overtime pay.

1.82 Permissible causes for suspending work.

1.83 Field revision of plans, substitution of materials, departure from recommended installation methods, conflicts between plans and specifications, conflicts with other trades.

1.9 Temporary and Related Conditions

1.91 Electric service for lighting, power and heat during construction or installation periods.

1.92 Advertisements, signs, notices.

1.93 Use of installation photographs for commercial purposes.

1.94 Cutting and patching.

1.95 Excavation and backfill.

1.96 Installation of sleeves, chases and openings.

1.97 Repair and maintenance.

1.98 Removal of debris from premises during and after completion of work.

To protect all parties involved in a contract, the specification should eliminate all possibility of misunderstanding or confusion. Therefore, any conditions contained in the document should be presented in detailed form.

For example, typical clauses from the General Conditions of a specification might appear as follows:

1.12 Scope

The work covered by this specification shall include furnishing all labor, material, equipment and services to construct and install the complete electrical system as shown on the accompanying plans and specified herein. This work shall include the following:

A. Outdoor high-voltage switching station.
B. Underground feeders from switching station to unit substations in plant.
C. Unit substations including primary disconnect facilities, transformer, and secondary switchgear.
D. Complete distribution system for lighting including necessary transformers, feeders, distribution panelboards, branch circuits, lighting fixtures, control switches and receptacles.
E. Complete distribution system for power including busduct feeders, branch-circuit plug-in type disconnects, and cable drop connections to motors.
F. Underfloor duct distribution system, first floor, office area.
G. Cellular floor distribution system, second and third floor, office building.
H. Empty raceways and cabinets for Bell Telephone system.
I. Receiving, handling, setting and connecting motors and controls.
J. Clock system, including provision of clocks and regulators.
K. Paging, including fire alarm and security systems, provision of equipment.
L. Lighting system; parking lots.
M. Grounding.

1.121 Work Not Included

The following equipment items and work shall be the responsibility of others.

A. Motors and controls listed below shall be furnished by the owner but shall be moved, installed and connected by the electrical contractor as indicated on the electrical plans. (List items.)

B. Telephone system wires, cable, equipment and instruments—furnished and installed by Telephone Company.

C. Elevator signal and control wiring beyond service feeder noted on plans—by others.

D. Controls for motors on mechanical equipment listed below will be furnished by others but shall be installed and wired by the electrical contractor. (List items.)

1.13 Drawings

The (architect's, engineer's) drawings, which constitute an integral part of this contract, shall serve as the working drawings. They indicate the general layout of the complete electrical system: arrangement of feeders, circuits, outlets, switches, controls, panelboards, unit substations, service equipment, fixtures, and other work.

Field verification of scale dimensions on plans is directed since actual locations, distances and levels will b governed by actual field conditions.

The electrical contractor shall check architectural structural, plumbing, heating and ventilating plans t avert possible installation conflicts. Should drastic changes from original plans be necessary to resolve such conflicts, this contractor shall notify the (architect, engineer, etc.) and secure written approval and agreement on necessary adjustments before the installation is started.

Discrepancies shown on different plans, or between plans and actual field conditions, or between plans and specifications shall promptly be brought to the attention of the inspector, engineer, architect, etc., for a decision.

The following drawings are part of this specification and contract:

Drawing No.	Date	Title
E-1	9- 1-60	High-Voltage Switching Station
E-2	9- 1-60	Underground Distribution
E-3	9-15-60	Power—Manufacturing Area
E-4	9-15-60	Lighting—Manufacturing Area
E-5	10- 5-60	Office Electrical—1st Floor
E-6	10- 5-60	Office Electrical—2nd Floor
E-7	10- 5-60	Outdoor Lighting

These drawings may be superseded by later revised or detailed drawings or specification addenda prepared by the (architect, engineer) and the contractor shall conform to all reasonable changes without extra cost to the owner. All items not specifically mentioned in the specifications or noted on the drawings but which are obviously necessary to make a complete working installation shall be included.

1.131 Shop Drawings

If shop drawings are to be required of the contractor, a statement to this effect should be included in the specifications. This may be handled as follows:

The contractor shall submit to the (architect, engineer) detailed dimensioned shop drawings covering all items of equipment and brochures of all lighting fixtures. No equipment should be put into manufacture (or ordered) until these shop drawings or brochures have been approved by the (architect, engineer).

The following procedure shall be followed: The contractor shall submit .... prints of shop drawings to the (architect, engineer) for comment or correction. The contractor shall then submit .... sets of prints of corrected shop drawings to the (architect, engineer) for final approval. The same procedure shall apply in making shop drawing revisions.

Frequently, contractors are requested to prepare and submit to the architect or engineer a set of dimensioned "working drawings" showing location of equipment, conduit runs, outlets, pull boxes, junction boxes—particularly if field conditions dictate a variation from original plans. When this is intended, such a statement should be included in the specifications.

1.21 Submission of Bids and Award of Contract

Bid proposals shall be made on forms provided by .... Proposed prices shall be indicated both in figures and in writing. Proposals shall be signed by the bidder or his duly authorized representative, with his address, firm name, title, etc. Bidder's bond shall be executed on the form attached to the proposal form.

All bids shall be presented under sealed cover plainly identified as a proposal for the work bid upon and shall have enclosed therewith a cashier's or certified check for $............ (an amount equal to .... percent of the proposed bid) and made payable to .... The right is reserved to reject any or all proposals or to award the contract to the responsible bidder with the lowest proposal complying with all prescribed requirements.

The contract award, if approved, will be made within .... days after opening of sealed bids. Within .... days after bid opening, the owner or his representative will return the proposal guarantees accompanying proposals not to be considered in the award of the contract.

The successful bidder shall sign the contract in duplicate counterpart and return it, with the contract bond, within .... days after receipt of contract award notice. The contractor shall also sign a set of plans and specifications for filing with the contract.

1.24 Extra Work

For any extra electrical work the (architect, engineer, owner) may propose, this contractor shall furnish to the (architect, engineer, owner) an estimate of the cost (lump sum) (material, labor and insurance cost plus .... percent for overhead and profit) of such work. The electrical contractor shall proceed only after receiving a written order from the (architect, engineer, owner) establishing the agreed price and describing the work to be done.

1.44 Method of Payment

The contractor shall be paid monthly, as the work progresses, an amount equal to the cost of the work installed that month less .... percent of the indicated cost as a retained percentage. Monthly payments shall be based upon the contractor's written statement of equipment and materials installed and labor expended for that month. Verification by the engineer will be required before certificates of payment are issued. No payments will be authorized until any defective work and materials have been removed, replaced and made good.

Within .... days after completion of the work by the contractor and its acceptance, in writing, by the (engineer, architect, owner), the unpaid balance of the contract price will be paid under a certificate issued by the (engineer, architect, owner).

1.51 Safety Precautions

The contractor shall furnish and place proper guards for prevention of accidents. He shall provide and maintain any other necessary construction required to secure safety of life or property, including the maintenance of sufficient lights during all night hours to secure such protection.

1.62 Specification by Brand Name

Where materials, equipment, apparatus, or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the bid. Materials so specified shall be furnished under the contract, unless changed by mutual agreement. Where two or more designations are listed, choice shall be optional with the contractor.

1.63 Material Substitutions

It is the intent of these specifications to establish quality standards of materials and equipment installed. Hence, specific items are identified by manufacturer, trade name, or catalog designation.

Should the contractor propose to furnish materials and equipment other than those specified, as permitted by the "or approved equal" clauses, he shall submit a written request for any or all substitutions to the (architect, engineer, owner). Such a request shall be (an alternate to the original bid) (a separate proposal); shall be accompanied with complete descriptive (manufacturer, brand name, catalog number, etc.) and technical data for all items; shall indicate any addition or deduction to contract price.

Where such substitutions alter the design or space requirements indicated on the plans, the contractor shall include all items of cost for the revised design and construction including cost of all allied trades involved.

Acceptance or rejections of the proposed substitutions shall be subject to approval of the (architect, engineer, owner). If requested by the (architect, engineer, owner), the electrical contractor shall submit for inspection samples of both the specified and proposed substitute items.

In all cases where substitutions are permitted, the contractor shall bear any extra cost of evaluating the equality of the materials and equipment to be installed.

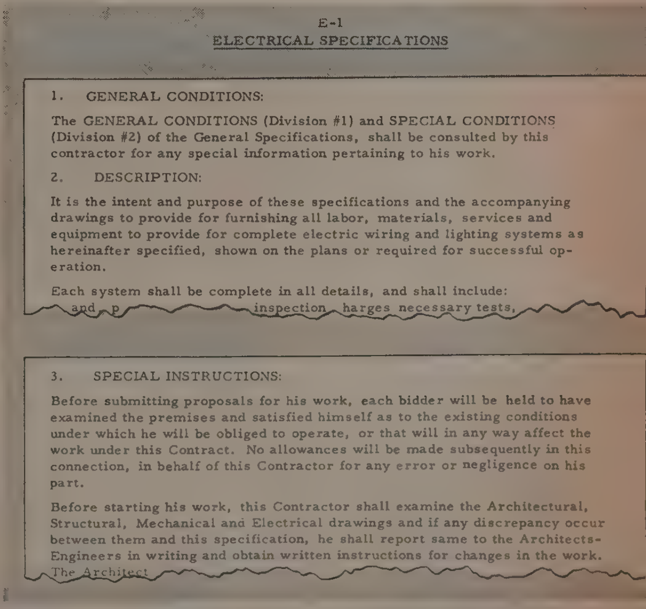
1.91 Temporary Power

The electrical contractor shall furnish, install, maintain, and remove after construction is completed, a .... ampere, ... volt, ... phase, ... wire temporary power and lighting system as shown.

The system shall consist of a service, distribution system, panelboards, grounding, branch circuits, and receptacle outlets as shown on the drawing.

Each trade shall provide and pay for its own extensions for lights or power tools beyond the receptacle outlets on the columns; and beyond the 3-phase panelboard submains in the case of 3-phase power tools.

The general contractor shall pay all energy charges for electric current used for temporary lighting and power.



E-1
ELECTRICAL SPECIFICATIONS

1. GENERAL CONDITIONS:

The GENERAL CONDITIONS (Division #1) and SPECIAL CONDITIONS (Division #2) of the General Specifications, shall be consulted by this contractor for any special information pertaining to his work.

2. DESCRIPTION:

It is the intent and purpose of these specifications and the accompanying drawings to provide for furnishing all labor, materials, services and equipment to provide for complete electric wiring and lighting systems as hereinafter specified, shown on the plans or required for successful operation.

Each system shall be complete in all details, and shall include:
and p inspection harges necessary tests,

3. SPECIAL INSTRUCTIONS:

Before submitting proposals for his work, each bidder will be held to have examined the premises and satisfied himself as to the existing conditions under which he will be obliged to operate, or that will in any way affect the work under this Contract. No allowances will be made subsequently in this connection, in behalf of this Contractor for any error or negligence on his part.

Before starting his work, this Contractor shall examine the Architectural, Structural, Mechanical and Electrical drawings and if any discrepancy occur between them and this specification, he shall report same to the Architects-Engineers in writing and obtain written instructions for changes in the work.
The Architect

SPECIAL INSTRUCTIONS, or supplementary conditions, directed at specific trades are sometimes included in specification subdivisions (in this case, electrical).

2.0 Service Entrances

CHECK LIST

- ☐ **Bus Assembly or Bus Duct** — size, voltage, phase and number of conductors
- ☐ **Characteristics of Service** — volts, amperes, phase, number of wires
  - — primary — over 600 volts (2.4 kv; 4.16 kv; 6.9 kv; 13.8 kv; etc.)
  - — secondary — 600 volts and under (120/240; 208/120; 480/277; etc.)
- ☐ **Conductors** — type (insulation) and size
  - — single conductor
  - — multi-conductor assembly
- ☐ **Connections** — types of cable connectors to be used, splicing instructions, etc.
- ☐ **Disconnecting Means** — service equipment
  - — primary — circuit breakers, interrupter switches
  - — secondary — circuit breakers, switches and fuses
- ☐ **Ducts** — conduit (metal, fiber, asbestos-cement, plastic, tile, etc.)
- ☐ **Emergency Service Facilities** — standby generator, battery sets, etc.
- ☐ **Equipment** — details of service equipment (may be covered in Section 4.0)
- ☐ **Grounding** — methods and details of grounding service and equipment
- ☐ **Location of Service Equipment** — exact location on property or building
  - — point of attachment to utility lines
- ☐ **Multiple Service Requirements** — different voltages
- ☐ **Routing of Service Entrance** — overhead — pole line and service drop
  - — underground — trenching details and protection
- ☐ **Structures** — details of switching and/or transformer structures
  - — outdoor structures
  - — indoor vaults
  - — manholes for underground service
- ☐ **Other Items** — dictated by specific project

Service-entrance specifications should cover in detail all facilities (including overhead and underground circuits) required to bring power from the utility lines to the "service" equipment within the building. Facilities can range from the simple pole-line secondary service to a more complex system involving primary lines, switching centers, transformers, and feeders to distribution equipment.

Incoming service systems may incorporate enclosed busways, specially designed bus structures, interlocked armor cable, multiple conductors per phase enclosed in parallel conduits or ducts, direct burial cables or conductors, multi-conductor cables, aerial cables, or special insulations for open wiring. Also included are relevant equipment and accessory items associated with power cutoff or interruption, circuit protection, primary (or secondary) metering and grounding.

All items involved in the service system as designed should be covered in definitive specification clauses establishing quality and capacity levels. Specifications should be explicit concerning type, size and number of cables; method of supporting the distribution medium; details of installation and protection; type, size, location and installation of associated equipment items.

Where multiple services are indicated (power, lighting, emergency, etc.) details of such service sources should be clearly stated in the specifications. Means of providing emergency power (batteries, generators, etc.) and means of transferring from one source to the other (automatic transfer switches) should be detailed in the specification clauses.

Where primary distribution from a switching center to a large number of unit substations is extensive, specification clauses regarding such feeders may be included under Section 5.0 Feeders.

The Service Entrance section of a typical electrical specification could include any or all of the following examples of typical clauses indicated in boldface type.

2.1 Characteristics

Define the service characteristics—voltage, frequency, phase, and number of wires. This information should also be noted on the relevant plans accompanying the specifications.

2.11 Primary Service Entrance

Specifically state what primary service work is to be done by the electrical contractor, giving necessary details on equipment locations and service facilities. Generally this phase of the work is done by the serving utility, but there are cases where part of it is done by the electrical contractor. For example:

The electrical contractor shall furnish and install two primary ...... kv underground .... in. fiber duct systems encased in a .... in. concrete envelope, as shown on Drawing No. ..... One duct line shall originate at

the (utility) Company . . . . . . kv lines on . . . . . . Street; the other at similar lines on . . . . Street. Both ducts shall terminate at the (utility) Company outdoor substation behind the plant boiler house. The (utility) Company will furnish and install all . . . . kv cables in these ducts and do all wiring for their transformers and switchgear concerned with the . . . . kv system.

The electrical contractor shall (furnish and) install a . . . . kv outdoor, metalclad switching center consisting of . . . . . . (interrupter switches and fuses) (circuit breakers) of capacities as noted on Drawing No. . . . . . This contractor shall furnish and install the No. . . . ., ... insulated, ... kv cables, ground cable and conduit systems between the incoming . . . . kv sections of the metalclad switchgear and the secondary busses of the (utility) Company outdoor substation, and make all connections to these busses.

This contractor shall furnish and install the necessary conduits and wiring between the metalclad switchgear and the meter house as required by the (utility) Company, also the ground rods and underground cable system for equipment ground of the outdoor metalclad switchgear and grounding of metal fence around switchgear.

In an installation of this type, primary service entrance can be considered to terminate at the outdoor switchgear. From there on out, it is a primary distribution system to the various unit substations within the plant or building. Specification clauses concerning such feeders can be added here, or included in the section on Feeders (5.0).

2.12 Secondary Service

Power for distribution within the building will be available from the secondary side of transformers supplied by the (utility) Company. This service shall be . . . . amp, ... phase, ... wire, .../. . . . volts, 60-cycle, alternating current for normal power and lighting requirements. General arrangement of the transformer vault, switchgear room and connecting main is shown in Drawing No. . . . . . Conductor sizes and enclosures shall be as noted on this drawing.

The electrical contractor shall (furnish and) install all equipment items and connections to the secondary side of the transformers and make all wiring connections to the current transformers and tie busses as shown. This contractor shall furnish and install the tie busses, limiting lugs, terminals, etc., to make a complete connection in each case. Bus tie shall be (size), (type) conductor as noted on plans. Terminals for secondary connections at the transformers shall be supported independently from the transformers so that any transformer may be easily removed.

2.13 Auxilliary Services

Specify any auxiliary services required by the system design—such as batteries, motor-generator emergency sets, other voltages or frequencies, direct current, and similar "special use" systems. Typical specification clauses for emergency service sets follow.

2.131 Standby Generator

Furnish and install where indicated on Drawing No. . . . ., an emergency standby generator rated at . . . . kw, ... volts, ... phase, 60-cycle. It shall consist of a . . . . engine direct-connected to a single-bearing, 4-pole generator with associated equipment to automatically start the engine upon failure of normal power source and to automatically transfer the emergency load from the normal power source to the standby generator.

Generator shall be of saturated field, 4-pole, revolving armature design, connected direct to engine flywheel by a semi-flexible steel driving flange to insure permanent alignment. Generator shall be rated . . . . kw continuous output, ... volts, ... phase, ... cycle with an inherent 10% voltage regulation from no-load to full-load. Engine shall be cranked through the generator exciter through a special 12-volt cranking winding with current obtained from a 12-volt battery. Batteries shall be recharged from the exciter with charge rate controlled by an automatic regulator.

Engine shall be a . . . . cycle, ... cooled type with . . . . cylinders and a displacement of . . . . cubic inches. Rating shall be . . . . hp maximum at . . . . rpm operating speed. Engine shall have automatic choke, 12-volt battery ignition and gear-driven distributor.

The wall-mounted control panel shall contain a magnetically held transfer switch, automatic engine-starting relays and a cranking limiter to open the starting circuit after about 45 seconds if engine fails to start. A 4-position control switch shall permit selection of "stop," "manual start," "test," and "automatic" positions. Control panel shall contain a 12-volt battery trickle charger to maintain full charge on starting batteries.

Generator unit instrument panel shall contain a water temperature and oil pressure gauge; battery charge rate ammeter; 12-volt panel light; stop, start buttons; manual reset circuit breaker; necessary voltmeters and ammeters and a duplex plug receptacle outlet.

The complete emergency standby generator unit shall be as manufactured by the . . . . . . Company, or approved equal.

2.132 Storage Battery Set

Furnish and install, where indicated on Drawing No. . . . ., a storage battery emergency standby set capable of providing total emergency electrical load for a period of two hours, complete with control panel to operate at building current and a suitable means of maintaining batteries in fully charged condition.

The storage battery shall consist of . . . . cells capable of delivering . . . . amps for a period of two hours, when fully charged, to a final voltage of not less than 105 volts across the battery terminals.

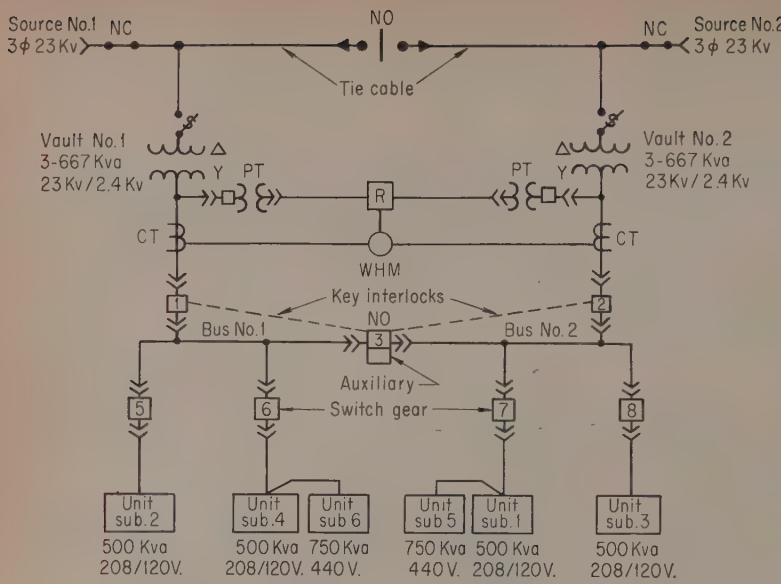
The automatic control cabinet shall contain a double-pole automatic switch to transfer emergency circuit from normal supply source to battery unit upon failure of normal supply and vice versa when normal service is again restored. This transfer switch shall be mounted in an accessible place and rated . . . . amps, ... volts, to carry the total connected emergency load. The face of the control cabinet shall contain a voltmeter, a battery ammeter and a switch for control of the emergency circuit.

Circuit protection shall be provided for protection of the normal supply circuit, and the charging device, of the same type as specified for panelboards.

A rectifier, capable of charging the . . . . cell battery, shall be accessibly mounted in the cabinet. Rectifier shall be designed for use on available building current and shall have an approximate average charging rate of . . . . amps. When connected through proper resistance in the cabinet, the charger shall be capable of trickle charging the battery at the proper rate.

All equipment shall be left in operating condition and copies of detailed instructions covering maintenance, care and operation of the equipment shall be furnished.

The storage battery emergency standby unit shall be as manufactured by the . . . . Company, or approved equal.



POWER DISTRIBUTION

ONE-LINE DIAGRAM presents clear picture of electrical system service and distribution design. Definitive clauses in relevant specification sections give size and quality details of materials and equipment to be installed.

2.14 Multiple Entrances

When the system design calls for more than one service entrance, specify and list each separately. This may cover separate services for fire pumps, emergency lighting, different voltages, varied occupancies and similar items.

2.2 Conductors

List the number, sizes, type of insulation, voltage rating and, where considered necessary, construction characteristics of all conductors specified. Such information facilitates cost estimating and purchasing of conductor items.

2.21 Cables

Where cables are to be of a special type (other than the common building types listed in the NEC) or for use on high-voltage systems, definitive clauses describing such cables should be included in the specifications.

All cable for the 13.2-kv system shall be 300 MCM, 15-kv, single conductor, shielded for a grounded system, with coated copper conductors, butyl base insulation and neoprene base jacket. Cable shall be (manufacturer), (trade name), Specification No. ......, or approved equal. All such cable shall be in accordance with, and conform to the latest requirements of the Insulated Power Cable Engineers Association.

The electrical contractor shall fireproof all high-voltage cables exposed in manholes and cable closets. Fireproofing shall consist of an inner wrap of (manufacturer) (trade name) asbestos tape applied wet and covered with a layer of (manufacturer) No. ...... cable wrapping tape, 2 in. wide and 1/16 in. thick, applied with a half lap and with the ends tied with lead or zinc wire. All ducts from manhole to building shall be sealed at the manhole end with (manufacturer) (trade name) seal compound.

2.22 Connections

Be specific about method of making cable connections at terminal points.

All 15-kv cables shall terminate in a solder type watertight lug. Cable ends shall be filled with solder to prevent moisture from entering between the cable wire strands. After stress cone has been made, cable and lug shall be protected with a moisture seal of No. ......, (trade name) plastic tape wrap.

All conductor terminals, taps and splices shall be made (by soldering) (with approved pressure connectors). All contact surfaces shall be cleaned to assure maximum conductivity.

2.23 Splices

Tell precisely where and how cable splices should be made.

All high-voltage splices shall be made with a splice approved for the specific type of cable installed and in accordance with recommendations of the cable manufacturer. The electrical contractor shall employ an experienced cable splicer to make all terminations and splices in the high-voltage cables.

2.24 Identification

Specifications should be definite about the extent of color coding of conductors throughout the system; also tagging at terminals for identification purposes. If conduits, raceways or enclosures are to be painted distinctive colors for identifying systems, or voltages, this item should be included in the specifications. If the electrical contractor is to be responsible for such painting, the specification should clearly state this.

2.25 Testing

Clearly state what electrical system tests are to be made by the electrical contractor, when they are to be made and in whose presence (architect's owner's, engineer's representative) they should be conducted.

This contractor shall test all wiring and connections for continuity and grounds before equipment is installed. When directed by (architect, engineer, owner) he shall demonstrate by Megger test the insulation resistance of any selected circuit or group of circuits.

This contractor shall test all high-voltage distribution

cable after installation and before energizing by applying (alternating) (direct current) potential. (Describe selected test procedure.) Test period shall be .... minutes.

Before energizing the system, this contractor shall check all connections and set all relays and instruments for proper operation. He shall obtain necessary clearances, approvals and instructions from the serving utility company.

If new testing equipment is to be furnished by the electrical contractor for later transfer to owner, clearly state this in the specification giving necessary data as to equipment type.

2.3 Routing

Supplement layout on plans with definitive specification clauses relating to service conductor point of origin, termination, equipment location, whether service is overhead or underground, methods of installing and terminating service conductors.

2.31 Overhead Service

From pole line, pole transformer, elevated transformer structure, aerial cable, etc. Note number, type, spacing, and method of installing poles and conductor supports if additional poles are required on the customer's premises.

2.32 Service Drop

State clearance from roof, ground, walls, windows, doorways, shafts, etc., and point of attachment to building.

2.33 Service Connections

Specify means of attachment of service conductors and mechanical protection necessary. This clause covers such items as potheads, service-entrance heads, sealed raceways, entrance through building and connection in indoor equipment. For example:

High-voltage cable shall terminate at potheads having the rated voltage and conductor capacity to accommodate the cable used. Potheads shall be .... Company, No. ...., or approved equal, with mounting as required by the conduit system installed. Potheads shall be filled with compound suitable for high voltage service. Heating and pouring instructions of the pothead and compound manufacturers shall be followed.

2.34 Underground

From street main, duct line, ground vault, street pole line, etc. Indicate size, voltage and insulation of conductors. Note whether service conductors are to be buried directly in a trench (add any required mechanical protection between conductors and backfill). If enclosed in a raceway, state size, type (metal, fiber, plastic), and mechanical protection (concrete envelope, etc.) required. Note point of connection at utility pole and type of mechanical protection necessary. Detail specification clauses can be included under sub-section Ducts 2.35.

2.35 Ducts

This section can include location and specification of other materials related to the service or type of conduit, bus duct, concrete envelopes (thickness, mix ratio, reinforcing rodding), open wiring, type of pipe bends and elbows, transposition means (conduit-duct, cable-bus, etc.) and means of termination at manholes and other structures.

Furnish and install four 4-in. ducts in two tiers from the utility vaults to the customer vault as shown on Drawing No. .... Ducts shall be fiber conduit, ... type, as manufactured by the .... Company, or approved equal. All sleeve joints shall be waterproofed as per manufacturer's recommendations. Ducts shall be enclosed in a concrete envelope extending at least 3 in. beyond duct exteriors; concrete to have a mix ratio of .... cement, ... sand, ... coarse hard gravel, and water. Ducts shall be installed not less than .. in. below finished grade and shall be graded away from the interior vault.

2.36 Structures

Supplemental detailed drawings in the plan set with specification clauses covering pertinent construction features of manholes, vaults, etc.; plus definitive sections on provision of facilities for pulling and racking cables, drainage, access facilities, and relevant items.

The electrical contractor shall furnish and install manholes and vaults of sizes indicated on the plans for primary electric service and telephone service. Vaults and manholes shall be constructed of reinforced concrete, complete with manhole covers and rings, sump drain, cable pulling rings, cable support racks and other facilities as detailed on the drawings. Outside of the structures shall be waterproofed with a bituminous compound in a manner approved by the (architect, engineer, owner).

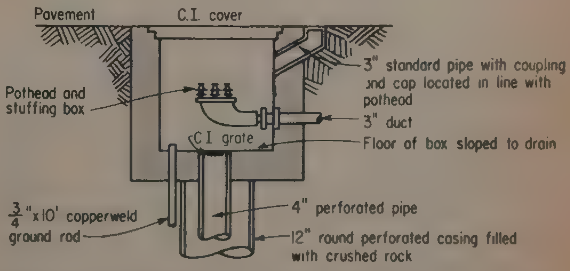
2.4 Equipment

List the service-entrance equipment items to be installed by the electrical contractor. State clearly which items are to be furnished by others and which by the contractor. Where equipment is a standard catalogue item, give manufacturer's name and catalogue designation to simplify specification clause and establish material quality. Where equipment is to be custom-built, give necessary assembly and construction details including pertinent information as noted in sub-sections 2.41 to 2.43.

Service equipment description may be expanded or completely covered under Section 4.0, Circuit Switching and Protection.

2.41 Disconnecting Means

State whether disconnection means (main and branch) are to be: circuit breakers (air or oil, manually or electrically operated, automatically tripped); interrupter switches and fuses (high voltage); or switches and fuses.


Pavement
C.I. cover
Pothead and stuffing box
3" standard pipe with coupling and cap located in line with pothead
3" duct
C.I. grate
Floor of box sloped to drain
$\frac{3}{4}$"x10' copperweld ground rod
4" perforated pipe
12" round perforated casing filled with crushed rock

DETAIL SKETCHES like this for an outdoor underground service structure clarify intent and meaning of specification descriptive paragraphs.

Note ratings, characteristics, terminal connection methods and construction details (where necessary).

2.42 Circuit Protection

List the overcurrent and interrupting capacity rating for each disconnecting means.

A typical specification clause for a circuit breaker might read:

The main circuit breaker shall be .... Company, Model (or Type) ......, or approved equal. Breaker shall be rated .... amps at .... volts ac, with trip adjustable from .... amps to .... amps at .... volts; shall have an interrupting rating of ...... rms amps at ... volts. Branch-circuit protective devices shall be rated as shown on the (plans) (schedule).

2.43 Transfer Switches

Where an emergency service is included in the electrical system design, specify the type, rating, and operating features of the automatic service transfer equipment. Where dual incoming lines serve the system, this item is normally an integral part of the service equipment assembly.

Where emergency service is provided by a standby unit (generator or batteries), this transfer switch item is normally included in the control equipment specifications for the unit (Sections 2.131 and 2.132). State if switch is part of unit or separate.

The electrical contractor shall furnish and install, where shown on the plans, a .... pole, ... amp, ... volt, ... phase, ... cycle, double-throw, electrically operated and mechanically held automatic transfer switch with .... second delay engine-starting relay and contact. The device shall automatically transfer the load to the emergency generator set when the main supply voltage drops to .... % normal value; shall automatically restore load to main supply when its voltage returns to .... % normal.

The switch shall be (enclosed in metal cabinet) (installed on panel) as indicated on the plans. Switch shall be .... Company, Bulletin (Catalog No.), or approved equal.

2.5 Grounding

2.51 Grounding Methods

All electrical systems must be grounded in accordance with provisions of the National Electrical Code. Depending upon the size, characteristics of the system and local area conditions, any or all of the following methods may be specified: ground to cold water piping system, metal building framework with deep footings in moist earth, driven rod assemblies, buried plates, metal mesh or conductor grid arrangements.

Descriptive specification clauses should supplement detailed drawings of the grounding system. The following are typical specifications:

Grounding shall be accomplished by means of "grounding assemblies" as indicated on Drawing No. ....

SINGLE ROD ASSEMBLIES shall consist of one ...... ground rod, ... in. diameter, and .... ft long with a clamp at the top and a No. .... bare stranded copper conductor to equipment to be grounded. Ground conductor shall be buried .... in. in the ground.

THREE-ROD assemblies shall comprise three ...... ground rods each .... in. diameter, and .... ft long spaced .... ft apart in the form of an equilateral triangle; a ...... clamp at top of one rod to accommodate a No. .... bare stranded ground cable to equipment to be grounded; and a No. .... bare stranded copper cable circling the three rods .... in. below grade and brazed to each rod.

WATER PIPE CONNECTION. Furnish and install a No. .... Type ...... conductor in a .... in. rigid (galvanized) conduit from the neutral bus in the lighting switchboard to a 1-in. or larger cold water pipe in the boiler room. Water pipe connection shall be with a ...... ground fitting that bonds both conduit and conductor to water pipe. Furnish and install a No. ...., Type ...... bonding jumper with approved ground clamps around the water meter.

GROUNDING BUS in the switchboard room shall be (size) copper bus bar, as shown on plans, mounted .... in. above finished floor. Bus shall be drilled and tapped to receive a No. .... grounding cable connection from the three-rod ground assembly and ground connections for equipment in the switchboard room.

Furnish and install a (size) copper bus bar from the main ground bus to each equipment item. Bus shall be recessed flush in the finished floor. Necessary grounding and patching around bars to be done by the electrical contractor.

2.52 Bonding Methods

Specify bonding methods to insure ground continuity at expansion pull boxes or conduit sleeves, cable sheaths in manholes, etc.

Bonding jumpers to maintain ground continuity at raceway and pull box expansion joints shall be No. ... stranded cable, or (size) copper braid installed with approved ground fittings.

Grounding jumpers shall be installed across all water meters in the building. Jumpers shall be No. ... stranded cable, or (size) copper bus securely attached to the water pipe with approved ground fittings.

2.53 Installation

The tops of all ground rods shall extend .... in. above finished grade.

Ground plates, metal mesh arrangements, ground cable grids and cables connecting ground rod assemblies and grounded equipment shall be installed .... in. below finished grade.

Grounding conductors shall be so installed as to permit shortest and most direct path from equipment to ground.

Unless otherwise specified, all ground conductors shall be installed in exposed metal conduit with both conductor and conduit bonded at each end.

All connections to ground conductors shall be accessible for inspection and made with approved solderless connectors brazed (or bolted) to the equipment or structure to be grounded. All contact surfaces shall be thoroughly cleaned before connections are made to insure good metal to metal contact. Follow engineer's recommendations.

Ground busbar shall be continuous throughout its length without joints or splices. All taps from the main ground busbar shall be of approved solderless connection with all contact surfaces clean. Cap screws, bolts, nuts, and washers shall be silicon bronze.

2.54 Tests

The resistance between ground and absolute earth shall not exceed .... ohms and shall be measured by the electrical contractor in the presence of (authorized personnel) before equipment is placed in operation.

3.0 Transformers

An increasingly greater number of transformers is being used and specified in the design and installation of modern electrical distribution systems. For engineering and economic reasons, higher in-plant and in-building distribution voltages are being used to carry large blocks of power with smaller copper to highly concentrated load areas. At these points transformers step down primary distribution (from 2.4 to 13.8 kv) voltages to secondary utilization levels (120/208, 480, 480/277, etc.). Secondary feeders, circuits and their inherent power losses are kept to an absoluate minimum.

Several equipment developments have expanded the practical application range of transformers to interior wiring systems in plants, commercial buildings and high-rise residential (apartment) structures. Among them are:

a. The metalclad unit substation or power center; an integrated combination of transformers and switchgear fully self-contained and protected and designed for free standing installation without vault protection in industrial plants and large buildings.

b. The variety of dry-type transformers, ranging in capacity from about 1½ kva to approximately 5,000 kva, which require no special enclosures and may be installed in practically any indoor location.

c. Transformer design improvements which reduce noise level. Units now have sound level (decibel) ratings that can be matched to application limitations. This is an important consideration in commercial building and apartment areas where transformer hum might be objectionable.

Specifications and drawings should reflect such installation and operating considerations as: transformer location; accessibility; inspection ease; surrounding structural conditions; atmospheric conditions (dust, humidity, moisture, corrosive elements, etc.). Indicate type of ventilation and/or filtered air circulation facilities to be installed; also dimensional separation between transformers and between units and adjacent walls.

Transformer noise level is another basic specification consideration where dry-type units are to be installed in areas where transformer hum might be objectionable. Definitely specify decibel rating of selected units to be installed in specific areas. Make this an integral part of desired characteristics—such as kva, voltage, phase, etc.

Reflected noise can be reduced by placing transformers at a 5° to 15° angle (rather than parallel) to adjacent walls. Addition of sound-absorbing material to walls and room interiors also helps attenuate noise. If either one or a combination of these techniques is to be used be sure to indicate same in the specifications with particular emphasis on transformer location.

Where a number of small single-phase transformers are used on a feeder to provide utilization voltages for lighting, receptacles, etc., specifications should clearly indicate that the primary connections of such units should be balanced on the 3-phase feeder circuit.

System design considerations affecting transformer installation should be reflected in the specifications. A transformer specification may be contained in a single paragraph or group of clauses; or it may consist of a

CHECK LIST

- ☐ **Application**
  - — main transformer
  - — master station
  - — load center substation
  - — local transformation
  - — special purpose
- ☐ **Characteristics**
  - — primary voltage and connections
  - — secondary voltage and connections
  - — frequency
  - — kva rating
  - — impedance
  - — percentage taps, number
  - — polarity
  - — noise level, decibel rating
  - — type of coils and enclosure
- ☐ **Type of Transformer**
  - — liquid cooled
    - a. oil
    - b. non-inflammable liquid
  - — air cooled dry type
  - — sealed dry type, inert gas filled
- ☐ **Related Equipment**
  - — bus structure
  - — primary switching
  - — secondary switching
  - — instrumentation
  - — temperature alarm system
  - — ventilation
    - — natural circulation
    - — fan forced circulation
- ☐ **Location and Installation**
  - — outdoor fence-enclosed concrete mat
  - — separate building or vault enclosure
  - — indoor vault or special room
  - — roof, open or structural enclosure
  - — indoor balcony, open or enclosed
  - — main floor
  - — roof truss or building columns
- ☐ **Related Drawings**
  - — one line diagram
  - — vault construction, noise attenuation, ventilation
  - — mounting and support details
  - — plan and elevation for equipment alignment
- ☐ **Other items** dictated by specific project

related series of numbered or itemized statements. In either case, such statements or clauses should be explicit. A complete specification could cover any or all of the following detailed information. Examples of typical clauses are shown in boldface type in following paragraphs.

3.1 Application

Cover intended use, purpose, relation to other sections of the system.

3.11 Main Transformer

Where utility primary service is stepped directly to desired utilization level, as in a simple radial distribution system.

3.12 Master Station

Generally supplied by primary service conductors, with secondaries in turn supplying two or more transformer substantions located in various parts of the customer's premises. A typical general clause may be as follows.

Master station shall be designed for (outdoor or indoor) installation. It shall consist of transforming and coordinating combinations of high-voltage and low-voltage switchgear, installed in accordance with the feeder diagram and at the location shown on the plans.

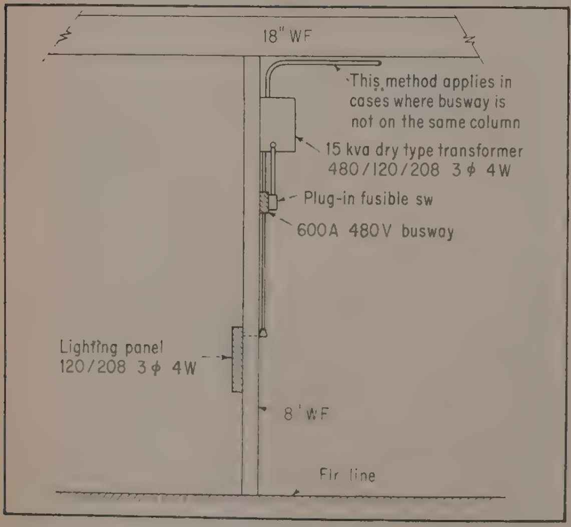
This should be supplemented by relevant equipment clauses.

3.13 Load-Center Substation

Where in-plant distribution voltage is stepped to utilization level near center of electrical load. Transformer may be separate unit or integrated with a unit substation. (See Section 4.0–Unit Substations 4.3)

3.14 Local Transformer

For specific application; located as close as possible to that item or application, such as lighting installation, individual motor or group of machines, bus structure for small tools, etc.


18" WF
This method applies in cases where busway is not on the same column
15 kva dry type transformer 480/120/208 3 ϕ 4 W
Plug-in fusible sw
600A 480V busway
Lighting panel 120/208 3 ϕ 4W
8' WF
Flr line

COLUMN-MOUNTED dry-type transformer fed by power bus duct permits spot service to lighting panels throughout a plant.

Average Sound Levels (Decibels) For Various Occupancies

(Use as guide for specifying sound-rated transformers)

Occupancy	Decibel Range
Apartments and hotels	35–45
Average factory	70
Classrooms and lecture rooms	35–40
Hospitals, auditoriums, churches	35–40
Private offices, conference rooms	40–45
Offices—small	53
—medium (3 to 10 desks)	58
—large	64
—factory	61
Stores—average	45–55
—large (5 or more clerks)	61
Residence—without radio	53
—with radio, conversation	60
Radio, recording, television	25–30
Theaters, music rooms	30–35
Street—average	80

Note: Manufacturers now market dry-type transformers up through 50 kva, single phase and 150 kva, 3 phase, with rated sound levels of 45 decibels or below measured in accordance with NEMA Standard ST 1–4.11.

A typical prototype specification clause might read as follows:

All dry-type transformers shall be . . . phase, 60-cycle, two-winding type; . . . volt primary; . . ./. . . volt secondary with grounded neutral. Rated capacity shall be. . . kva (or as otherwise noted herein or on the plans). All transformers shall have (number) . . % full capacity taps (below) (above) normal.

Units shall be designed for quiet operation with a decibel rating not to exceed . . . db; shall be (floor, wall, ceiling) mounted on . . . vibration eliminators. Circuit connections shall be in (rigid) (flexible) (metal) (non-metallic) conduit in approved manner.

Transformer shall be Type . . ., as manufactured by . . . . . . Company, or approved equal.

3.15 Special Transformers

For applications other than normal power, lighting and heating; such as X-ray and high-frequency use, low voltage for remote control or signal systems, electric furnaces, electric discharge lighting, hazardous locations, current transformers, etc.

3.2 Characteristics

3.21 Nameplate Data

Rated kva, frequency, primary and secondary voltages, percent taps, manufacturer, serial number, style, form, polarity, impedance. If pertinent, add decibel level.

3.22 Ratings

Transformer shall be rated for . . ./. . . kva, oil insulated (non-inflammable liquid filled, air cooled, etc.), 3 phase, 60 cycles, . . . °C temperature rise, . . . volts delta primary, . . . volts wye secondary, with solidly grounded neutral. High-voltage windings shall be provided with 2½% taps, two above and two below normal, externally operated manual tap-changer handle arranged

for padlocking in each position. Taps may be changed only when transformer is de-energized. They provide means for adjusting to average supply voltage.

Automatic tap-changing equipment for operation under load shall be installed on low-voltage side to maintain constant voltage on low-voltage terminals (or some point on the feeder).

Transformer shall be Type . . . . as manufactured by the . . . . . . Company, or approved equal.

3.23 Liquid Filled

Oil.
Non-inflammable liquid.

3.24 Dry

Air cooled: natural convection, fan-forced.
Sealed: inert gas filled.

3.3 Construction

3.31 Switches

Primary and secondary disconnecting mediums, connections for parallel operation (secondary ties).

3.32 Bus Structure

Primary and secondary, copper or aluminum.

3.33 Enclosure

Sealed transformer tank shall be equipped with drain and sampling valves, filter-press connections, magnetic oil gauge with alarm contacts, relief diaphragm, ground block and top-oil dial-type thermometer. It shall also have nameplate, delta-wye terminal board, neutral bushing, provision for future addition of automatically controlled fans to give continuous overload rating of . . . kva.

3.34 Related Instruments

Where pertinent, specify instruments to be furnished with transformer such as oil gauge, dial-type thermometer, pressure-vacuum gauge, etc. Add details of temperature alarm system—visual, audible or both. When transformer is integral part of a self-contained power center or unit substation, metering and control facilities are incorporated in the unit sub specification.

3.35 Related Sections

(See Section 4.0—Unit Substation 4.3)

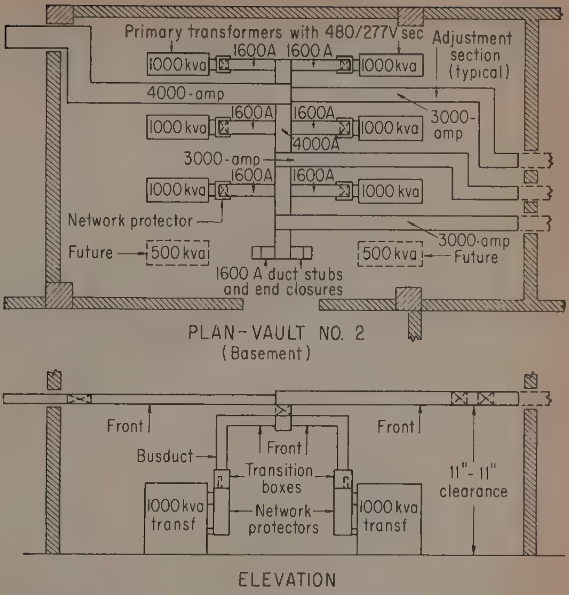
3.36 Details of Accessories

Bushing, core and coil details.

High-voltage bushings shall be stud (pothead, wiping sleeve, etc.) type, cover (or sidewall) mounted. Low-voltage bushings shall be stud (etc.) type, cover mounted. All bushings shall have suitable gaskets to provide a tight fit.

Individual high-voltage and low-voltage coils shall be wound on separately formed barriers in order to facilitate removal of the coils in case of repairs being required. Windings shall consist of copper (or aluminum) coils suitably insulated, thoroughly dried and vacuum treated.

Core shall be manufactured of high-grade non-aging sheet-steel laminations, properly annealed, treated and insulated from each other in accordance with approved practice.



TRANSFORMER-VAULT plan, with relative location of units and complex secondary connections, gives estimator and installing contractor clear picture of designer's intent.

These transformers shall be guaranteed against load and total losses, and the limiting dimensions and net and shipping weights; also the regulation at 100% and 80% power factor shall be given. Testing shall conform to ASA transformer standards, and units must meet all ASA acceptance tests.

3.4 Location

Indicate transformer location, with dimensional details if necessary. Check local utility regulations.

3.41 Outdoor

Give explanatory clauses describing outdoor installation. Cover such features as: (pole mounted, roof, fenced, concrete pad, external wall brackets, housed, protected, etc.).

The following is a typical descriptive specification:

The main outdoor transformer station shall include a complete packaged . . . column switching structure for control of the incoming . . . kv circuits. It shall have spacing, clearances and mechanical details in conformity with NEMA Power Switching Standards. The structure shall be of galvanized steel (or aluminum), completely shop fabricated with column and trusses assembled, and including bolts for erection, mounting and anchoring; station luminaires, control cable within station.

Also to be included are . . . kv bus supports and fittings, connectors, conductors, strain, and grounding materials to interconnect the station apparatus. The outdoor station shall also include a concrete pad to support transformers and switchgear (per following specifications).

3.42 Indoor

State how transformers are to be installed (vault, platform or balcony, basement, interior walls, column or truss brackets).

Give pertinent information about transformer vault or room (construction, ventilation, drainage, access, type of door, foundation channels, bolting arrangements, service facilities). Add detailed drawings where necessary.

4.0 Circuit Switching and Protection

CHECK LIST

☐ **Circuit Characteristics**
— voltage
— phase
— ampere load
— interrupting capacity

☐ **Service-Entrance Equipment**
Primary
— circuit breakers
— interrupter switches
Secondary
— circuit breakers
— fused switches
— bolted pressure-contact switches
— combination circuit breakers and fuses

☐ **Primary Distribution Center**
— interrupter switches, number and size
— circuit breakers, number and size
— type of equipment enclosure
— associated wiring and connections

☐ **Unit Substation**
— primary and secondary disconnect
— transformer type and rating
— low-voltage section
— number, type and size of units
— substation construction
— type and arrangement of enclosure
— instrumentation
— bus and connection data
— circuit tie and interlocking

☐ **Control Center or Switchboard**
— main disconnect
— type, size
— branch-circuit units
— number, type and size
— construction
— type and arrangement of enclosure
— bus and connection data
— metering or instrumentation details, if any

☐ **Panelboards — Power and Lighting**
— size and arrangement of main bus
— number of branch-circuit devices
— circuit breakers
— fuse and switch assembly
— size and number of poles of each
— enclosing cabinet and trim, doors and locks
— flush — surface

☐ **High-Frequency Lighting Panels** — need for detailed specification clauses

☐ **Safety Switches**
— type and size

☐ **Capacitors**
— voltage
— kvar rating
— location
— switching, manual, automatic
— installation, single, group

☐ **Fuses**
— size and type
— one time
— renewable
— time delay
— dual element
— high interrupting capacity
— high-current limitation
— number of spares

☐ **Other items** dictated by specific project

Facilities for circuit switching and protection at various division points of an electrical system are generally covered by descriptive specification paragraphs or clauses covering selected related equipment items. These supplement riser diagrams and detailed equipment drawings.

Present design trends logically place such equipment in two basic classifications: primary (2.4 kv to 13.8 kv, etc.); and secondary (under 600 volts). This follows similar classifications in Section 2.0 Service Entrances, and Section 5.0 Feeders. A complete primary and/or secondary distribution specification can be developed by selecting applicable clauses from these and other relevant specification sections.

In addition to normal ratings (volts, amperes, phase, overcurrent protection), interrupting capacity is becoming an increasingly important specification requirement—particularly on equipment for service-entrance use. Protection must be provided against the higher short-circuit or fault-current levels inherent with today's increased power generation and transmission capacities. Engineering analysis of distribution system impedance and available short-circuit currents is reflected in selection and specification of interrupting-capacity-rated equipment.

Depending upon design concept, circuit switching and protection equipment may be designated as:

a. Individual, enclosed externally operable switch and fuse (or circuit breaker) items; or a group of enclosed fused switches (or circuit breakers).

b. Assemblies of fused switches (or circuit breakers) in a single enclosure, such as distribution and branch-circuit panelboards.

c. Totally enclosed, free-standing, metalclad switchgear such as a distribution center, load center, motor-control center, or unit substation with integral transformer. When such equipment is to be delivered in a number of site-connected sections, or cubicles, indicate same as well as dimensional data. This type of information helps the contractor estimate accurately the equipment handling and installation time.

Specification information on circuit disconnects and protection component items should include: voltage, phase, number of poles, overcurrent rating, interrupting-capacity rating (where pertinent), number of units, type of enclosure.

Where distribution and branch-circuit panelboards, load centers, or switchgear are involved, specify the number, type (copper or aluminum) and capacity of main busbars; rating (as above) and type (fused switch or circuit breaker) of main disconnect; the number (quantity), rating (as above) and type (fused switch or circuit breakers) of branch-circuit devices; plus the number of spare units or spaces to be included in the assembly.

This information may be presented in descriptive form, or by simply indicating a manufacturer's catalog number if the selected equipment is a standard catalog item.

4.1 Service-Entrance Switches

Service-entrance equipment may be installed separately or in combination with switching centers or distribution panelboards or switchboards. Clearly indicate on the plans and in the specifications which type is intended and include pertinent descriptive information.

4.12 Primary Service Equipment

a. Interrupter switches.

b. Circuit breakers.

Indicate manufacturer's name, type number, or other identifying designation; number of poles, volts, amperes, interrupting capacity and type of operation (manual) (automatic). Specify type and style of enclosure (indoor or outdoor) and type of conduit or cable entrance and exit fittings; pertinent data on enclosed equipment.

A typical specification for an interrupter switch might read as follows:

The electrical contractor shall furnish and install a 3-pole, 2-position (open-close), group-operated, fused air-interrupter switch rated . . . amps with an interrupting rating of . . . amps at . . . kv. Switch shall be Type . . . . as manufactured by . . . . . . Company, or approved equal; shall be mounted in a suitable metal enclosure equipped with an interlock to permit access to fuses only when switch is in open position.

Power fuses shall have an interrupting rating of . . . . amps RMS, . . . kva symmetrical at . . . . volts; shall be . . . . Type as manufactured by . . . . . . Company, or approved equal.

4.13 Secondary Service Equipment

a. Fused switch: The electrical contractor shall furnish and install where shown on the plans a . . . amp, . . . volt, . . . pole (solid neutral) fused switch in a NEMA Type . . enclosure as a service-entrance disconnect. Switch shall be UL listed as suitable for use as service equipment.

Switch shall be of the positive-action, quick-make, quick-break type with interlocking cover that prevents opening door when external handle is in "on" position. Switch shall be . . . . . . Company, Type . . ., Catalog No. . . ., or approved equal.

In the 1200-amp to 6000-amp range, up to 600 volts, bolted pressure-contact switches are available as service-entrance equipment. They are used with high-capacity current-limiting or non-current limiting fuses (as required). When the design incorporates equipment of this type, follow the above specification procedure noting make, type, electrical rating, enclosure (ventilated); also make, type, rating and number of high-capacity fuses.

b. Circuit breaker disconnect: The electrical contractor shall furnish and install where indicated on the plans a . . . amp, . . . volt, . . . pole circuit breaker in a NEMA Type . . . enclosure. Breaker shall be manually operated, trip-free and designed so that all poles open simultaneously. Tripping mechanism shall be (thermally, magnetically) operated; shall open instantaneously on short circuits and have time delay on overloads; shall have effective sealing against tampering. Breaker shall be Type . . ., Catalog No. . . ., as manufactured by the . . . . . . Company, or approved equal.

Coordinated combinations of circuit breakers and current-limiting fuses are available for use as high-capacity secondary service equipment where fault currents beyond the interrupting ratings of the breakers will be encountered. The fuses interrupt the high fault currents and protect the breakers. Specification of this type of equipment should follow that of conventional circuit breakers with attention directed to specific characteristics of the selected fuses. Recommendations of fuse manufacturers should be closely followed when selecting and specifying fuses for this type of application.

Where service-entrance disconnecting means is to consist of two to six switches (circuit breakers) in a common enclosure, as permitted by Section 230-70 (g) of the National Electrical Code, clearly indicate this on the plans and in the specifications. Indicate the voltage, ampere rating and number of poles of each disconnect, fuse or overcurrent protection size, number and size of main busbars and type of enclosure. If assembly is standard catalog item, give manufacturer's name and catalog designation, or approved equal; if special assembly, show detailed drawings.

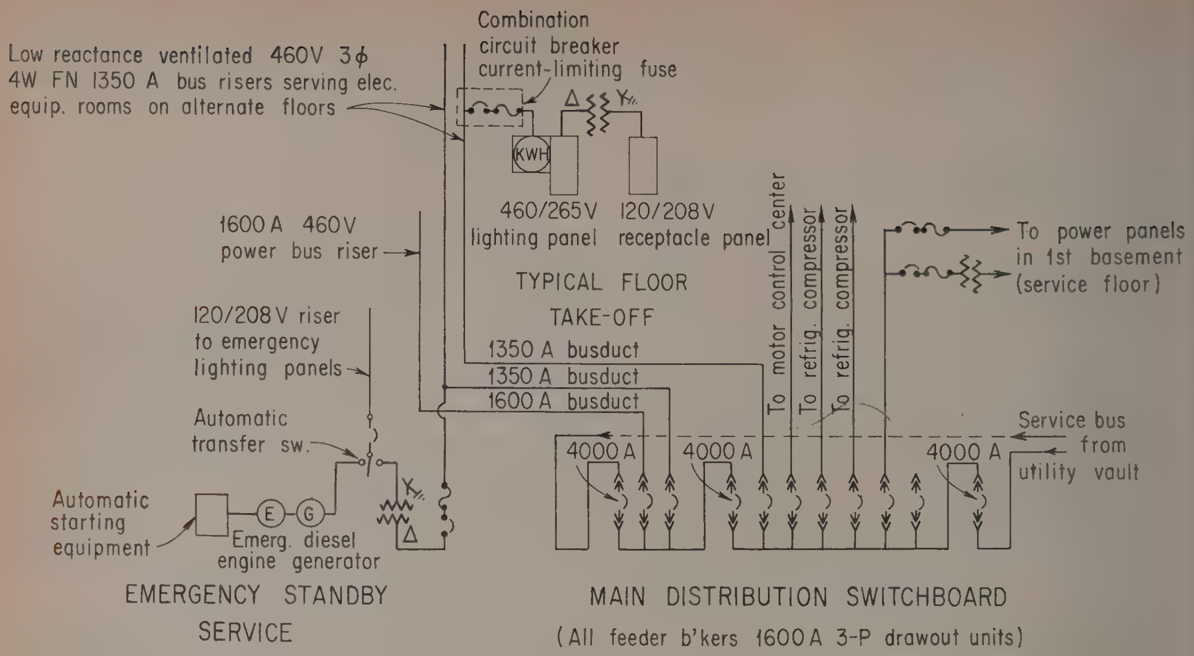
4.2 Primary Distribution Center

The electrical contractor shall (furnish), receive, install and connect the complete . . . kv switching center in the . . . as indicated on the drawings. The assembly shall consist of (number) free-standing metal (steel, aluminum) cubicles, each containing a (fused interrupter switch, circuit breaker) of capacity noted on the drawings.

Cubicles shall be of (indoor, outdoor) type and shall be set on and securely fastened to leveled structural steel members as indicated on the drawings. Connections to the service transformers shall be made with (conduit and cable) (high-voltage bus) as noted. Feeder cable connections shall be made to terminals provided in each cubicle.

The electrical contractor shall also furnish and install a complete lighting system for the switching center as noted on the drawings and furnish and install necessary conduits for power company's metering circuits. All work shall meet with (utility company, owner, engineer) approval.

Primary switching units shall be as manufactured by the . . . . . . Company, or approved equal.


Combination circuit breaker current-limiting fuse
Low reactance ventilated 460V 3ϕ 4W FN 1350 A bus risers serving elec. equip. rooms on alternate floors
KWH
460/265V lighting panel
120/208V receptacle panel
TYPICAL FLOOR TAKE-OFF
1600 A 460V power bus riser
120/208V riser to emergency lighting panels
1350 A busduct
1350 A busduct
1600 A busduct
To motor control center
To refrig. compressor
To refrig. compressor
To power panels in 1st basement (service floor)
Automatic transfer sw.
Automatic starting equipment
E
G
Emerg. diesel engine generator
4000 A
4000 A
4000 A
Service bus from utility vault
EMERGENCY STANDBY SERVICE
MAIN DISTRIBUTION SWITCHBOARD
(All feeder b'kers 1600 A 3-P drawout units)

ONE-LINE DIAGRAM of a secondary main distribution switchboard shows major switching and protection points, also types and sizes of equipment devices to be installed.

The equipment will be shipped in . . . . sections to facilitate handling and installation.

4.3 Unit Substations

The electrical contractor shall (furnish) receive, move, assemble, install and connect the unit substation(s) as indicated on the plans and in accordance with drawings furnished by the manufacturer.

This contractor shall install the necessary level structural channels on which the units are to be securely fastened; also all connection and pull boxes, conduits, supports and other circuit accessories necessary to make all high-voltage and low-voltage connections.

Unit substation(s) shall be as manufactured by the . . . . . . Company, or approved equal. Each substation shall consist of an incoming primary section with a . . . kv (interrupter switch) (circuit breaker); a transformer section with a . . . kva, . . . / . . . volt, 3-phase, air-cooled transformer; and a low-voltage section containing (number) air circuit breakers of sizes noted for secondary feeders. Also necessary tie-breaker, metering and transition cubicles as indicated.

All connections, devices and instruments shall be checked thoroughly for proper operation before the unit is energized.

Unit substations must be tailored to the specific electrical system design with respect to transformer rating, and number and sizes of secondary-circuit control devices. A typical detailed equipment specification for a specific unit substation might read as follows:

The secondary selective unit substations shall be rated . . . / . . . kva, 3 phase, transforming from . . . volts to . . . / . . . volts. They shall be arranged in sections of same height and depth.

Each substation shall consist of the following:

a. One incoming section with a . . . kv, 3-pole, single-throw, gang-operated dry-type load break switch integral with the transformer.

b. One transformer section with a . . . kva, 3-phase, 60-cycle, . . . volt delta, . . . / . . . volt wye, air-cooled type, natural draft, . . . °C rise, with four . . . % full capacity taps (two above and two below normal primary voltage), necessary insulated . . . kv bus, bare 600-volt bus and ground bus complete with connections and support. Forced air-cooling equipment facilities shall be provided to obtain . . . % greater capacity. This equipment shall be automatically controlled from winding temperature devices.

c. One main breaker section with stationary and removable elements, primary disconnecting devices and mechanical interlocks complete with one main air circuit breaker of proper capacity for substation rating, and tie air circuit breaker of proper rating for transfer of . . . % of substation rating, each draw-out type, triple pole, single throw, electrically operated, rated 600 volts, . . . rms amp interrupting capacity respectively with three time-overcurrent and instantaneous trip coils.

One ammeter, one voltmeter, transfer switches, potential and current transformers.

d. Two feeder-breaker sections with stationary and removable elements, primary disconnecting devices and mechanical interlocks complete with six (6) air circuit breakers, draw-out type, triple pole, single throw, manually operated, rated . . . amps, 600 volts . . . rms amp interrupting capacity with three time-overcurrent and instantaneous short-circuit trip coils and two spaces for future breakers.

Substations shall be arranged in pairs and equipped with secondary selective devices to operate as follows: Upon loss of bus voltage on one substation, its main breaker shall open and its tie breaker and the breaker of the second substation shall close automatically. When bus voltage is restored, the main breaker shall be closed manually, thereby opening both tie breakers.

4.4 Control Centers

The electrical contractor shall furnish and install a centralized control center of the self-supporting, totally enclosed metal (steel, aluminum) type consisting of standard modular dimension units as noted on the plans.

The complete control center shall contain main disconnect, branch-circuit breaker and combination line starters, and circuit-breaker disconnects of size and type and voltage noted on the drawings. Where required, start-stop and reset buttons shall be provided in the cover of each motor starter section.

Interior wiring shall be NEMA Class . . ., Type . . . (Class I, Type A, B, C) (Class II, Type B) (Class III, Type C).

Control center shall be furnished complete with necessary pull boxes, wiring gutters, assembled copper (or aluminum) bus connections, terminal blocks and all required control features.

All motor starters and branch breakers shall be (front, back-to-back) mounted and shall be easily accessible for maintenance, repair or replacement.

Control centers shall be as manufactured by the . . . . . . Company, or approved equal.

4.5 Switchboards

Furnish and install a dead-front type, completely metal enclosed, self-supporting secondary power switchboard consisting of (number) panels, or cubicles, containing circuit breakers (fusible switch assemblies) of the number, rating and type noted herein or shown on the drawings.

a. Circuit breakers shall be (stationary-mounted) (molded-case) (draw-out) type of capacities and number of poles indicated.

b. Fusible switch assemblies . . . pole (or as noted), quick-make, quick-break type mounted in a metal enclosure with an externally operated handle which can be locked in "on" or "off" position. Units shall be of sizes listed and shall be removable from the front of the board without disturbing adjacent units or the switchboard bus structure.

c. Current-limiting circuit breakers shall combine time-delay thermal-trip, instantaneous magnetic-trip, and fault-current limiting protection in one complete assembly. Units shall have ampere ratings as shown and an interrupting rating of . . . rms amps at . . . volts. Current-limiting fuses (protectors) shall be mounted in a special housing with safety-cover access from the front of the board.

Switchboard main bus and connections to switching devices shall be of (copper) (aluminum) of sufficient size to limit rated continuous current operating temperature rise to 30°C (50°C for circuit-breaker branches). All main bus and tap connections shall be silver surfaced and tightly bolted for maximum conductivity. Switchboard bus shall be braced for short-circuit stresses up to . . . rms amps (asymmetrical).

Switchboard shall be factory assembled, wired and tested before delivery, and shall conform to UL and NEC standards. Individual units (cubicles) shall be designed for bolting together at installation site and shall be bonderized and factory painted in standard finish.

Switchboard shall be as manufactured by . . . . Company, or approved equal.

4.6 Panelboards

4.61 Power and Distribution Type

Where shown on the plans, indicated in the riser diagram, and listed in the panelboard schedule, furnish and install distribution and power panels of the types and sizes noted. Panels shall be installed with top of cabinet . . . ft, . . . in. above floor level.

a. Panelboards shall be of the combination switch and fuse type with dead-front safety construction incorporating (hinged-cover swing out; pull-out; quick-make, quick-break, safety-interlocked, externally operable handle) branch-circuit units.

Panel bus structure shall be for . . . volt, . . . phase, . . . wire service and of sufficient capacity to feed the (number) . . . pole, . . . wire branch-circuit units indicated. Mains shall be equipped with solderless lugs. Branch-circuit units shall be of sizes indicated.

Panelboard assembly shall be enclosed in a code-gauge steel cabinet with flush (surface type) trim and ample wiring gutters on top, sides and bottom. Cabinet doors shall be equipped with spring (bar) latches (indicate whether locks are required and if all shall be keyed alike and how many keys are to be furnished).

Panelboards shall be Type . . . as manufactured by the . . . . . . Company, or approved equal.

b. Distribution panelboards shall be of the dead-front safety type equipped with thermal-magnetic (non-interchangeable) circuit-breaker branches of sizes and types noted on the drawings or indicated in the panelboard schedule. Breakers shall provide instantaneous trip on short circuits and time-delay trip on overloads.

Panel bus structure shall be for . . . volt, . . . phase, . . . wire service and of sufficient capacity to feed the number of branch-circuit breakers indicated. Main busbars shall be equipped with solderless lugs.

Panelboard assembly shall be enclosed in a code-gauge steel cabinet with flush (surface type) trim and ample wiring gutters on top, sides and bottom. Cabinet doors shall be equipped with spring (bar) latches (indicate whether locks are required and if all shall be keyed alike and how many keys are to be furnished with each panel).

Panelboards shall be Type . . . as manufactured by the . . . . . . Company, or approved equal.

4.62 Lighting Panelboards

All lighting branch-circuit panelboards shall be of the (switch and fuse, circuit-breaker) type of sizes listed in the panelboard schedule or noted on the drawings. Panels shall have mains only with solderless lugs on the main busbars and shall be arranged for service on a . . . volt, . . . phase, . . . wire system.

a. Branches shall have approved molded-block single-pole snap-switch units with (Type S) plug fuseholders.

b. Branches shall have single-pole, thermal-magnetic (non-interchangeable) circuit breakers of sizes noted.

Cabinets for lighting panelboards shall be of code-gauge steel with ample wiring gutters for all wires and connections. Doors shall be the single type (unless otherwise noted) with spring latches (note if locks are required, if they should be keyed alike, and how many keys should be furnished for each panel). Panel trim shall be furnished for flush (surface) mounting as noted.

Panelboards shall be Type . . . as manufactured by . . . . . . Company, or approved equal.

When lighting panelboards are to be of the narrow, single-row construction for mounting in the channel of H or I beams, so indicate on the plans and in the specifications. Include the necessary pull box containing the neutral bar and required wiring duct to connect column panel with pull box above.

4.63 High-Frequency Lighting Panels

Lighting distribution panels for high-frequency lighting systems differ from conventional panels and must be tailored to the specific type of system installed. Cir-

Panel No.	CKT. No.	Circuit breaker				Cable size	Cond. size	Serves
		Frame	Size	Poles	Trip			
MDP	1	KM *	600A	3	500A	6-250 MCM	(2)-2½"C	300 KVA
	2	KM *	600A	3	500A	6-250 MCM	(2)-2½"C	300 KVA
	3	KM	600A	3	400A	4-500 MCM	3½"C	4th Floor
	4	KM *	400A	3	250 A	3-250 MCM	2½"C	150 KVA
	5	KM	400A	3	225 A	—	—	Spare
277/480 V	6	K	225A	3	175 A	4-2/0	2½"C	LHW-C
	7	K*	225 A	3	125 A	3-2	1¼"C	Equip. Rm#1
	8	K	225A	3	100 A	—	—	Spare
	9	F*	100 A	3	70 A	3-6	1"C	Equip. Rm#2
	10	F*	100 A	3	70 A	3-6	1"C	Equip. Rm#3
	11	F	100 A	3	90 A	3-4	1¼"C	45 KVA
	12	F	100 A	3	90A	—	—	Spare
	* Breaker with 277 V shunt trip coil.							

SCHEDULE OF circuit-breaker types, sizes and trip settings in a main distribution panel. Added data on branch-circuit or feeder cable and conduit sizes plus area or load served makes this an ideal directory for operation and maintenance.

cuiting from the frequency converters have a definite bearing on panel arrangement. Until electrical components for new distribution concepts, such as this, become standard catalog items, it is advisable to be more detailed and explanatory in specification clauses and to provide detailed drawings of components.

A specification clause for a single high frequency lighting panelboard for a two-converter system might read as follows:

Furnish and install a (manufacturer's name), or approved equal, two-section, . . . circuit panelboard for the . . . cycle, . . . volt lighting system where indicated on the plans. Panel shall be rated . . . volts line to ground, and . . . cycles.

The top section of the panel shall contain (number), . . . amp, 2-pole, . . . volt circuit breakers with bus connections arranged so that each phase of the 3-phase, 6-wire, . . . cycle feeder from one converter feeds . . . branch-circuit breakers. Converter conductors shall be connected to a terminal block at the top of the panel.

The bottom section of the panel shall be a duplicate of the top section with terminal block at the bottom to receive conductors from the other converter.

A steel barrier shall separate the 2-panel sections.

Each 2-pole branch-circuit breaker shall control (number) high-frequency lighting fixtures as shown on the plans.

Panel shall be of the dead-front, safety type with a code-gauge sheet metal cabinet and hinged door with spring latch and suitable lock.

4.7 Capacitors

Where capacitors for power-factor correction are an inherent part of the electrical system design, show location of units on the plans. Specify type, voltage and kvar rating of units; also method of installation, individually or in banks on frames or racks designed for floor, wall, ceiling or column mounting. A prototype specification clause for such equipment might read as follows:

Capacitors for power-factor correction shall be . . . type as manufactured by . . . . . . Company, or approved equal. Individual units shall be rated . . . kvar for operation on . . . volts, . . . phase, . . . cycle circuits. Units shall be installed (individually) (in groups) as indicated on the plans and supported in a suitable frame or rack for (indoor) (floor, wall, ceiling, column), (outdoor) (pole, platform, ground) mounting. Operating losses shall not exceed . . . % of the kva rating. Installation shall be complete with necessary bus work, connectors and switching facilities (switches, CBs).

Circuit breakers (switches) shall be (manually) (electrically) operated and housed in an integral steel enclosure. Units shall meet UL, AIEE and NEMA standards.

4.8 Safety Switches

The electrical contractor shall furnish and install all (fusible, non-fusible) safety switches of sizes noted on the drawings. All switches shall be NEMA type (HD) (ND) quick-make, quick-break, in NEMA Type 1 general purpose enclosure with interlocking cover, unless otherwise indicated. Switches for motor circuits shall be horsepower rated. Switches shall be as manufactured by the . . . . . . Company, or approved equal.

Specify the number of special keys or devices to be supplied authorized personnel to disengage switch cover interlocking mechanism (for inspection or test) without interrupting service.

4.9 Fuses

Progressive developments in the design and protective capabilities of modern fuses demand careful consideration when selecting and specifying the variety of fuse types available for circuit and equipment protection. Where coordination with other fuse protective devices and circuit breakers is required, recommendations of manufacturers (fuse and breaker) should be followed. Hence the importance of one or several specification clauses indicating what type of fuse is to be used at specific protection points.

Also important is the mandatory requirement of Section 240-21 of the 1959 NEC that, effective January 1, 1961, all plug fuseholders and plug fuses shall be of Type S construction.

Typical clauses for fuses might read as follows:

Plug fuses shall be dual-element, time-delay, Type S of capacities noted on the (plans) (switchboard, panel, feeder schedules, etc.). Fuses shall be (trade name) as manufactured by . . . . . . Company, or approved equal.

Cartridge fuses shall be . . . volt (one-time) (renewable) of ampere ratings noted. Fuses shall be (trade name) as manufactured by . . . . . . Company, or approved equal.

Fuses indicated by symbol ( ) shall be . . . volt, dual-element cartridge type capable of carrying 500% indicated rating for a minimum of 10 seconds; shall have minimum short-circuit interrupting capacity of 100,000 RMS amps; shall have standard NEC dimensions. Fuses shall be (trade name) (or catalog designation) as manufactured by . . . . . . Company, or approved equal.

Current-limiting fuses indicated by symbol ( ) shall be . . . volt, silver-sand type with high degree of current limitation and a minimum short-circuit interrupting capacity of 200,000 rms amps. Fuses 600 amps and under shall have standard NEC dimensions; over 600 amps, dimensions to fit switchgear as specified. Fuses shall be (trade name or type) as manufactured by . . . . . . Company, or approved equal.

High-capacity current-limiting fuses indicated by symbol ( ) for circuits above 600 amps shall be . . . volt range with a minimum short-circuit interrupting capacity of 200,000 rms amps; shall have characteristics to coordinate with other fuses as noted; and dimensions to mount in switchgear as specified. Fuses shall be (trade name or type) as manufactured by . . . Company, or approved equal.

The electrical contractor shall furnish spare fuses consisting of one set for the mains and 10% of all sizes and types of other fuses installed on the project.

5.0 Feeders

Good feeder design takes into consideration electric demand, voltage drop and spare capacity for future system expansion. This is reflected in the plans and specifications. It is important to proper installation and system operation that all feeders be identified in the plans and specifications with pertinent information regarding size, voltage, insulation, supporting raceway, routing, installation and termination details.

Such information can be clearly listed in capsule form in a Feeder Schedule included on the plans or in the specifications. Schedule headings can be (reading from left to right): From–To; Feeder No.; Raceway type and size; Cable type, size, voltage, number of conductors; Length; and if necessary, pull, splice and cable support boxes.

If the feeder distribution system is extensive, feeder specifications can be divided into primary (over 600 volts) and secondary (600 volts or less) sections with separate schedules and specification clauses for each.

Physical characteristics of electrical feeders depend upon the design requirements of the specific project. Feeders may be conduit and cable, armored cable, aerial cable, busduct, etc. Clearly indicate with appropriate specification clauses, the physical composition, or "wiring method" pertaining to each feeder or group of feeders; plus definitive statements relating to transition from one type to another.

One method of developing a feeder specification is to start with a general description of the feeder system for the specific project, then add supplementary clauses covering individual components of the complete system as required by the design. The format of this section is designed to facilitate such an approach, with typical specification clauses appearing in boldface type.

5.1 Classification

5.11 Primary Feeders

The electrical contractor shall furnish and install a complete . . . volt, . . . phase, . . . wire primary feeder system from the . . . volt switching center to all unit substations as shown on Drawing No. . . . . Types and sizes of individual feeders shall be as indicated in the Feeder Schedule on the drawings (or in the specifications).

Add relevant supplementary clauses covering material items, installation methods, etc., to make a complete specification.

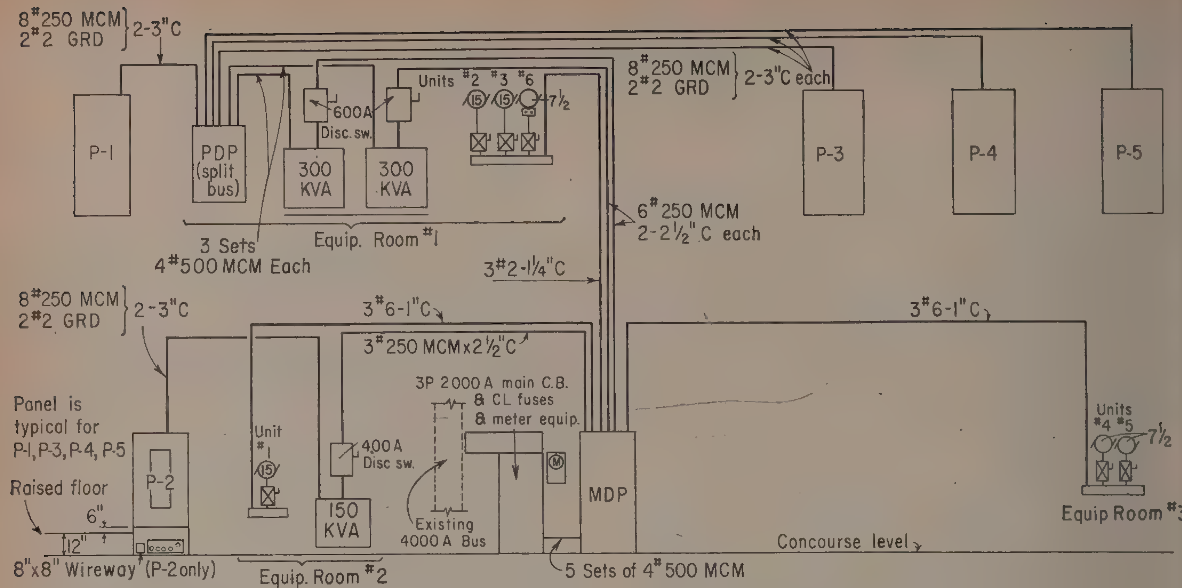
5.12 Secondary Feeders

Secondary electrical distribution within the building (or plant) shall be . . ./. . . volt, . . . phase, . . . wire for combined power and lighting. The electrical contractor shall furnish and install all feeders from the main switchboard (or unit substation sections) to the various distribution cabinets (or load centers) as shown on the plans (Drawing No. . . .).

Feeders shall be of the types and sizes indicated in the accompanying Feeder Schedule (Drawing No. or specification reference).

CHECK LIST

- ☐ **Bus Duct or Bus Assembly** — size, type, voltage, phase, number of conductors
- ☐ **Classification of Feeders** — voltage and phase
  - — primary — over 600 volts
  - — secondary — 600 volts and less
  - — high frequency — cycles and voltage
- ☐ **Conductors** — type (insulation), size, voltage
  - — aerial cable, self-supporting
  - — armored cable
  - — concentric or coaxial cable (hi-cycle systems)
  - — multi-conductor assembly
  - — single conductor
  - — open wiring
- ☐ **Feeder Schedule** — from — to, feeder No., raceway type, type and size of cable, length
- ☐ **Installation** — as noted on plans
  - Overhead
    - — conduit (metal, plastic, etc.)
    - — aerial cable supports
    - — cable troughs, wireways, ladder racks, etc.
    - — open wiring construction (indoors)
    - — pole line construction
  - Underground
    - — direct burial cables
    - — ducts (conduit — metal, fibre, asbestos-cement, tile, plastic, etc.)
    - — protection (concrete envelopes, creosoted planks, sand fill, conduit ells, etc.)
- ☐ **Routing of Feeders** — parallel to lot and building lines, clearances from other systems, etc.
- ☐ **Structures** — cable support, pull and splice boxes
  - — duct manholes
  - — special raceway supports
- ☐ **Terminations** — methods
  - — at switchgear, etc.
  - — at manholes
  - — splices and taps
- ☐ **Supplementary items** dictated by the specific project design



FEEDER INFORMATION on distribution plan establishes number and size of conductors and raceways for each feeder in system; supplements specification data; and simplifies estimating and installation.

Add relevant supplementary clauses covering material items, installation methods, etc., to complete the system specification.

If the design calls for separate feeders for power and lighting make this clear in the specifications and on the plans.

5.2 Underground Systems

5.21 Ducts and Cables

The electrical contractor shall furnish and install a complete underground distribution system for the . . . volt, . . . phase, . . . wire feeders shown on Drawing No. . . . . He shall be responsible for all excavating, draining trenches, forming of duct assembly and protective concrete envelope, backfilling and removal of excess earth.

Ducts shall be (steel, fiber, asbestos-cement, PVC plastic) conduits of sizes noted on the plans and in the Feeder Schedule. Ducts shall be as manufactured by (company), or approved equal. All duct joints shall be waterproofed according to manufacturer's recommendations.

All underground conduits shall be encased in a . . . in. by . . . in. concrete envelope of . . .-. . .-. . . mix and arranged in tiers as noted on the duct-bank cross-sectional drawing. Ducts shall be installed below normal frost line at least . . . in. below finished grade (at least . . . in. below grade for high-voltage feeders). Banked conduits shall be held securely in place, at a minimum . . . in. spacing between conduits, by approved separators installed at 5-ft intervals.

Where the concrete duct envelope crosses roadways, soft fill or other utility mains, it shall be reinforced with . . . in. steel reinforcing rods as shown in the duct cross-sectional drawing. Reinforcing shall extend . . . ft beyond area requiring additional protection.

Ducts shall be installed with a 3-in. per 100-ft downward slope from buildings or section high points toward manholes, which are to be provided with drainage facilities.

Conduit terminations at manholes and building walls shall be with endbells suitable for the type of duct installed. Spare conduits noted on plans shall be provided with a No. . . . galvanized steel drag wire. All ducts shall be swabbed clean before cable installation. Spare ducts shall be plugged at both ends and conduits provided with a watertight seal after cable installation.

Manholes shall be of the size and type indicated on the drawings. Cables shall be trained in manholes and supported on racks and hooks as indicated. The electrical contractor shall furnish and install all inserts, racks and supports necessary.

5.22 Direct-Burial Cables

Underground feeders of direct-burial cable type, where noted on the plans, shall be (company), (trade name), Type . . ., or approved equal, with a . . . conductor insulation and over-all . . . moisture-proof jacket.

Single-conductor (or multi-conductor) cables shall be of sizes indicated in the Feeder Schedule and shall be installed not less than . . . in. below finished grade. Cables shall rest on and be covered with a . . . in. layer of sand to prevent cable damage from sharp objects in the fill. Additional protection at points noted on the drawings, or specified herein, shall be provided by installing creosoted planks between cable sand and trench fill.

All cables shall enter manholes, building walls, or termination points through a protective galvanized-steel conduit sleeve of appropriate size. Open end of sleeves shall be provided with a moisture seal after cable is installed. Seal shall be type approved for system voltage and cable insulation.

5.3 Conduit Raceways

Where noted on the plans, overhead feeders shall be installed in conduit raceways of the sizes and types indicated in the Feeder Schedule. All conduits shall be securely fastened to building structure and run parallel or at right angles to building walls.

5.31 Conduit Type

Raceways shall be (describe protective coating and finish) heavy-wall, rigid steel (or aluminum) conduit as noted on the plans or specified herein. Steel conduit shall be manufactured of mild steel tube of uniform thickness and smooth circular bore and shall be approved for use as an electrical raceway. Conduit shall be furnished in standard 10-ft lengths free of defects.

Conduit shall be as manufactured by the ...... Company, or approved equal.

Where feeders are subject to highly corrosive atmospheres, as noted on the plans, conduit shall be (plastic-coated, or other corrosion-resistant type) as manufactured by the ...... Company, or approved equal.

Where riser conduits, accessible to unauthorized personnel, contain feeders above 600 volts, conduits shall be encased in a ... in. concrete envelope, or other approved protective means, for a distance of ... ft above floor level.

Conduit ends shall be cut square, threaded and reamed to remove burrs and sharp edges. Field threads shall be of same type and have same effective length as factory cut threads.

Conduit joints shall be made with approved couplings or unions. Bends and offsets shall be made with a hickey or power bender without kinking or destroying the smooth bore of the conduit. Paralleled conduits shall be run straight and true with offsets uniform and symmetrical.

Conduit terminals at cabinets and boxes shall be rigidly secured with locknuts and bushings as required by the NEC and local electrical code. On all conduit 1¼-in. trade size and larger, bushings shall be of the (insulated) (insulating with double locknut) type as manufactured by ...... Company, or approved equal.

5.32 Conduit Supports

Exposed conduits shall be securely fastened in place on maximum ... ft intervals; and hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet.

Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

Adjustable hangers may be used to suspend ... in. or larger conduits when separately located.

If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

Hangers shall be made of durable materials suitable for the application involved and shall be painted two coats of lead and oil paint. Where excessively corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by sherardizing or galvanizing, special paint or other suitable preservative methods.

The use of perforated iron for supporting conduits will not be permitted.

The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables.

5.4 Cable Boxes

The electrical contractor shall furnish and install junction boxes, pull boxes, cable-support boxes and wiring troughs as shown on the drawings, herein specified, or otherwise required. All boxes shall be of code-gauge steel with screw covers fastened with (corrosion-resistant) machine screws and painted to resist corrosion.

QUICK REFERENCE CHART OF SHEET METAL GAUGE

USS Gauge for Sheet and Plate Steel

	Thickness of Steel in Inches	
Gauge No.	Uncoated Sheets	Galvanized Sheets
8	.1644	.1681
10	.1345	.1382
12	.1046	.1083
14	.0747	.0785
16	.0598	.0635
18	.0478	.0516
20	.0359	.0396
22	.0299	.0336
24	.0239	.0276
26	.0179	.0217
28	.0149	.0187
30	.0120	.0157

Note: Due to variation in manufacture, a plus or minus tolerance of approximately 10% is generally recognized and allowed by some authorities.

Boxes shall be supported independently of conduits entering them. Brackets, rod hangers, bolts, or other suitable supporting methods may be used.

5.41 Pull and Junction Boxes

Pull boxes shall be fabricated from No. ... gauge sheet metal, with screw covers held in place by corrosion-resistant machine screws. Boxes shall be furnished and installed where indicated on the plans or where necessary to facilitate cable pulling and splicing. Box size shall be as required by the NEC for the number of conduits and conductors entering and leaving it.

Where feeder splices are to be made, box shall be large enough to provide ample work space.

5.42 Cable Support Boxes

Vertical cable support boxes made of No. ... gauge sheet steel shall be furnished and installed where indicated on the riser diagram. Boxes shall have removable screw covers fastened by corrosion-resistant machine screws; shall be large enough to accommodate the feeder conduits indicated and provide ample space to install cable supports in the riser conduits.

Individual two-bolt, clamp-type conduit supports of ... in. by ... in. steel shall be provided for each conduit at floor level. Ends of clamps shall extend sufficiently over opening to provide a firm conduit bracing on the floor.

CABLE SUPPORT SPACING IN VERTICAL RACEWAYS

Conductor Size	Maximum Space Between Supports—in Feet
No. 18 to No. 1/0	100
No. 2/0 to No. 4/0	80
250MCM to 350MCM	60
400MCM to 500MCM	50
600MCM to 750MCM	40
Above 750MCM	35

A handy reference check on spacing of riser feeder cable supports.

5.43 Cable Supports

Cable supports shall be of the ... type, of a size to fit the number and size of feeder conductors and size of conduit. Supports shall be (company), (trade name), or approved equal.

5.44 Wiring Troughs

Horizontal wiring troughs shall be furnished and installed where noted on the plans (over switchboards, for complex offsets and change of direction, in congested locations, etc.). Troughs shall be made of ... gauge sheet steel with ... finish; have screw covers and insulated cross-brackets to support conductors at .... ft intervals.

Troughs shall be of sufficient size to accommodate feeder conduits and cables and provide ample room for installing and training the conductors.

Where indicated, or considered necessary, troughs shall have steel barriers to separate feeder circuits.

All troughs shall be supported from the building structure independent of the conduits entering them.

Feeders in troughs shall be identified by fireproof tags or other approved method. Individual conductors of feeder circuits shall be tied together with cabling twine.

5.5 Accessible Raceways

5.51 Cable Trays

Furnish and install a metal (steel, aluminum) cable trough (or tray) system to support cable systems as indicated on the drawings. Troughs (or trays) shall be of the (expanded metal, or ladder) type, ... in. deep and of widths as indicated; shall be furnished in standard ... ft lengths complete with the required coupling accessories, elbows, tees, crosses, branch and reducer sections, and cable drop-out accessories.

Trough (tray) assembly shall be (bracket, rod, etc.) supported from the building structure as indicated on plans, with anti-sway brackets provided where necessary.

Approved cable support means shall be provided at top of long vertical runs. Cables shall be fastened to trough (tray) at ... intervals on horizontal runs.

Where indicated on the plans, provide an approved trough (tray) cover to protect conductors.

Troughs (trays) and all accessories shall be as manufactured by the ...... Company, or approved equal.

5.52 Wireways

Where indicated on the plans, approved wireways shall be furnished and installed complete with necessary complement of fittings, connectors and parts. Sizes shall be as indicated on the drawings and installation shall be in accordance with manufacturer's recommendations.

Wireways shall be as manufactured by the ...... Company, or approved equal. Wireways, fittings and connectors shall conform to applicable codes and standards.

5.53 Cable Pits and Trenches

State clearly in specifications where cable pits or trenches (under switchboards, etc.) are to be installed and method of terminating raceways and feeder cables at such locations.

5.6 Feeder Busduct

Furnish and install a complete system of ... phase, ... wire, ...% neutral, ... volt, interconnected, low-impedance feeder busduct of ampere ratings indicated on the plans and/or the feeder schedule. Provide the necessary transformer drop-outs, offsets, elbows, expansion joints, wall and switchboard flanges, cable-tap boxes, and switch adapters as noted.

Busduct runs shall be made up of standard factory fabricated and assembled sections interconnected by joints designed to maintain rigidity and strength. All sections shall carry the UL label and have a short-circuit strength meeting NEMA standards.

Busbars shall be fabricated from 98% conductivity copper (60% conductivity electrical conductor grade aluminum) and shall be silver-plated over (contact) (entire) surfaces.

Suitable removable-cover handholes shall be provided at section joints to permit standard high-contact pressure-bolted busbar connections.

All duct sections shall be furnished with standard hangers as indicated on the plans. All rods, straps, special brackets and other approved means of suspending the duct runs shall be furnished and installed by the electrical contractor.

All feeder busduct shall be ...... Company, Type ... or approved equal.

Where special installation conditions exist, supplement specification clauses with detailed drawings.

5.61 Weatherproof Duct

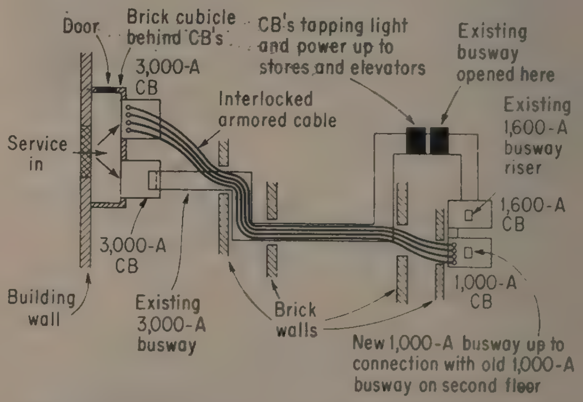
Where used outdoors, the feeder busduct shall have a weatherproof finish on the casing and suitable insulation around busbars for outdoor use. Duct shall bear UL label as "suitable for use outdoors."

5.62 Distribution Duct

Where busduct is to be used for distribution to individual electrical equipment, the "plug-in" type should be specified. Typical specification clauses for this type of duct are found in Section 6.0 Branch Circuits.

5.7 Armored Cables

Where noted on the plans, (primary) (secondary) feeders shall be of the interlocked armor cable type. Cable shall be ... conductor, ... volt, ... insulation, of sizes listed in the Feeder Schedule. The cable assembly shall be encased in a continuous interlocked spiral metal armor of (steel, aluminum, bronze). Cable shall be manufactured by the......Company, or approved equal.


Door
Brick cubicle behind CB's
CB's tapping light and power up to stores and elevators
Existing busway opened here
3,000-A CB
Interlocked armored cable
Existing 1,600-A busway riser
Service in
1,600-A CB
3,000-A CB
1,000-A CB
Building wall
Existing 3,000-A busway
Brick walls
New 1,000-A busway up to connection with old 1,000-A busway on second floor

INSTALLATION PLAN for revamping a distribution system shows definite location of new feeders and equipment with respect to existing items; clarifies specification intent.

Cables shall be strapped in place on girders and columns, following structural members closely, or supported by cable troughs or ladder racks as noted on the plans.

Troughs or racks shall be of (steel, aluminum) construction as manufactured by the ...... Company, or approved equal.

The electrical contractor shall furnish and install all brackets or structures necessary to support the racks. Where cables cross open areas, cable troughs or racks shall be suspended by a . . . in. steel messenger wire, or suitable catenary structure, as detailed on the drawings.

All cable splices and taps shall be made in approved fittings or junction boxes with cable connectors made up tight to provide a firm mechanical and electrical connection. Conductor connections shall be made with . . . type connectors and insulated for the cable voltage.

Conductor terminations shall be made in an approved manner with . . . type connectors. All contact surfaces shall be clean.

Primary cables shall be terminated with potheads having voltage and conductor capacity rating of the cables used, or other termination methods recommended by the cable manufacturer. Potheads shall be filled with compound suitable for the voltage specified and in accordance with manufacturer's recommendations.

5.8 Wires and Cables

5.81 Type and Insulation

All wire and cable for feeder circuits shall conform to the latest requirements of the current edition of the NEC and shall meet all ASTM specifications. Wire and cable shall be new; manufactured since (month, year); shall have size, grade of insulation, voltage and manufacturer's name permanently marked on outer covering at regular intervals; shall be delivered in complete coils or reels with identifying size and insulation tags.

Wire and cable shall be suitably protected from weather and damage during storage and handling and shall be in first-class condition when installed.

Wire and cable shall be as manufactured by the ...... Company, or approved equal.

Sizes, insulation and voltage rating shall be as indicated on the drawings and listed in the Feeder Schedule. In general, wires and cables shall meet the following relevant requirements.

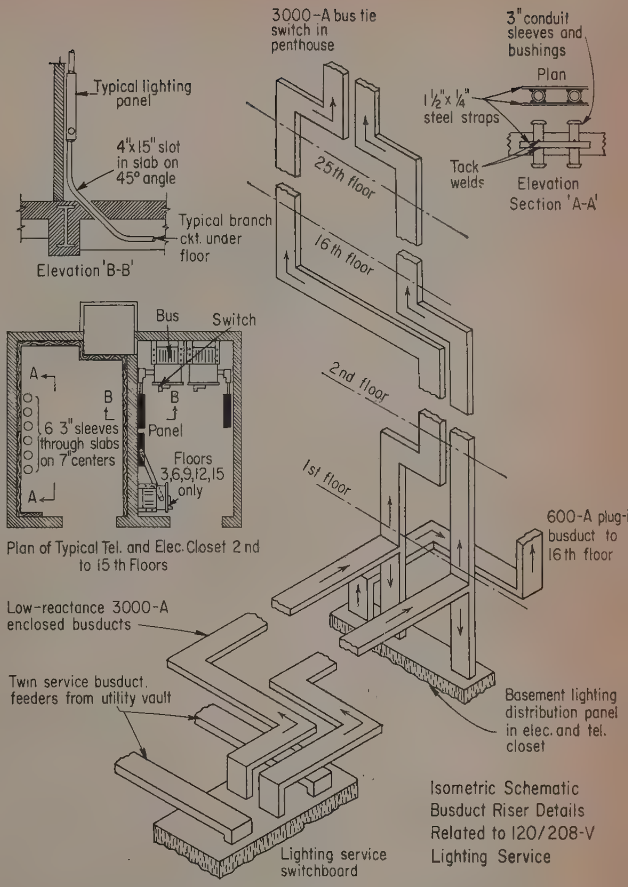
Conductors shall be soft-drawn copper (semi-annealed EC grade aluminum) with insulation and outer covering as noted. Conductor sizes shall be standard American Wire Gauge sizes. Conductors No. 8 and larger shall be stranded.

Wire and cable shall be factory color-coded, with a separate color for each phase and neutral used consistently through the system. Note the green coding required by the NEC for conductors intended solely for grounding purposes.

Conductors for high-voltage (primary) feeders shall be rated ... volts for the system installed. Insulation shall be ... around conductors with a ... outer covering.

Conductors for low-voltage (secondary feeders) shall be 600-volt, Type RH insulation (or other types, as noted) when installed in permanent dry locations above grade.

All 600-volt feeder conductors in conduits or other raceways encased in basement concrete slabs, slabs resting on fill, installed below grade, or where exposed to moisture or weather, shall have moisture-resistant Type (RW, RHW, TW, THW, AVL, etc.) insulation.


3000-A bus tie switch in penthouse
3" conduit sleeves and bushings
Plan
1½"x ¼" steel straps
Tack welds
Elevation Section 'A-A'
Typical lighting panel
4"x15" slot in slab on 45° angle
Typical branch ckt. under floor
Elevation 'B-B'
25th floor
16th floor
Bus
Switch
A
B
B
6 3" sleeves through slabs on 7" centers
Panel
Floors 3,6,9,12,15 only
A
Plan of Typical Tel. and Elec. Closet 2nd to 15th Floors
2nd floor
1st floor
600-A plug-i busduct to 16th floor
Low-reactance 3000-A enclosed busducts
Twin service busduct. feeders from utility vault
Basement lighting distribution panel in elec. and tel. closet
Isometric Schematic Busduct Riser Details Related to 120/208-V Lighting Service
Lighting service switchboard

ISOMETRIC RISER of a complex busduct feeder system shows number and type of fittings needed. Add dimensional data and you have a fabrication and installation drawing.

Where noted on the plans, or indicated in the Feeder Schedule, feeders in excessive high-ambient temperature areas shall have Type (AVA, AVB, etc.) insulation.

All conductors for open-wiring feeders, as noted on the plans, or in the Feeder Schedule, shall have Type . . . insulation (triple braid, Type SB, etc.).

5.82 Aluminum Conductors

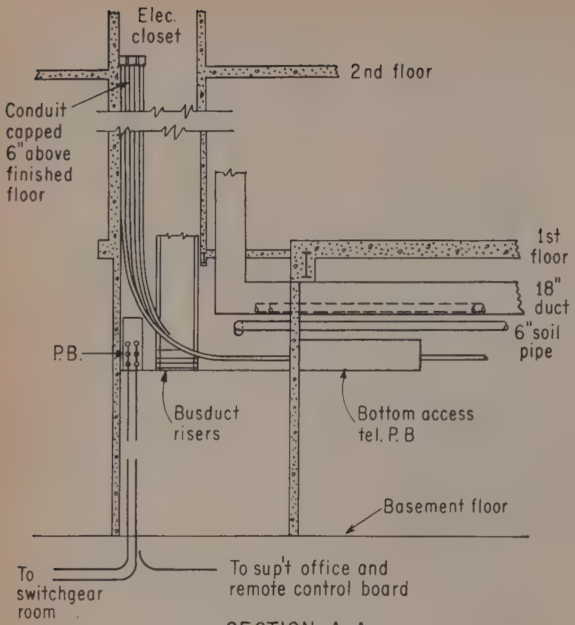
Where aluminum cables are indicated on the plans and in the Feeder Schedule, conductors shall be insulated aluminum EC grade, semi-annealed, of quality and physical characteristics specifically designed for use in interior wiring systems. Cable shall be of conventional sizes and current capacities as listed in the NEC.

Conductor sizes shall be as noted on the plans and in the Feeder Schedule. Conductor and cable insulation shall be Type . . ., as noted.

Wire and cable shall be ...... Company, (trade name), or approved equal.

Splices and terminals shall be made in an approved manner with connectors specially designed and approved for use with aluminum conductors.

All conductor ends shall be stripped of insulation carefully to avoid nicking the metal. Approved types of oxide-inhibiting compounds containing abrasive conducting particles shall be applied to the conductor and shall thoroughly penetrate spaces between strands.



SECTION A-A
Showing orientation of ducts, feeders and tel. conduits beneath tierred electrical closets

DRAWINGS like this showing orientation of multiplicity of ducts, conduits and piping do much to simplify and accelerate field installation.

Where bolted, pressure type connectors are used, they shall be specially designed for use with aluminum conductors and shall be drawn up tight to manufacturers' recommendations.

Where high-compression type connectors are used, they shall be of a type specially designed and approved for use with aluminum conductors. They shall be of exact size to fit the conductors and shall be installed with approved hydraulic tools to bring uniform pressure on all sides of the joint and assure a permanent high-conductivity connection.

Where connections are made between aluminum and copper (two dissimilar metals), provision shall be made to prevent electrolytic action and all connectors for this purpose shall be approved types.

Connectors shall be (company), Type . . ., (catalog number or trade name), or approved equal.

5.83 Detailed Specifications

Where feeder cables are to be other than standard building wire with other than standard code designations, it is frequently necessary to include a detailed cable specification. The following is a specification for a self-supporting aerial cable assembly describing a particular cable in detail:

The cable assembly shall consist of three single-conductors, each No. 4/0 AWG, 37 x .0756 concentric stranded tinned copper, covered with semi-conducting tape, insulated with ozone-resistant butyl-base rubber compound to a thickness of 10/64 in., cable and paper tape; 0.005-in. tinned-copper shielding tape and covered with a 5/64-in. neoprene jacket rated at . . . volts. The three single-conductors shall be cabled reverse lay and bound to a ½-in. Copperweld messenger with flat copper tape spiralled completely around the over-all assembly.

5.84 Cable Installation

No conductors shall be drawn into conduits until all work which may cause cable damage is completed. Only approved cable lubricants shall be used when necessary.

As far as practicable, all feeder cables shall be continuous from origin to panel termination without running splices in intermediate pull boxes or splicing chambers. Sufficient slack shall be left at the terminations to make proper connections.

Unless otherwise noted, each conduit raceway shall contain only those conductors constituting a single feeder circuit.

All cable terminals, taps and splices shall be made secure with solderless pressure-type connectors, unless otherwise specified. Connectors shall be Type . . ., manufactured by the . . . . . . Company, or approved equal.

Where compression-type connectors are noted on the plans and in the specifications, they shall be of the type as manufactured by the . . . . . . Company, or approved equal, and shall be installed with approved hydraulic tools to assure a permanent mechanically secure high-conductivity joint.

Where soldered joints are specified, the cable joint shall be mechanically strong before soldering. Solder shall be carefully applied without use of acid. Soldered connection shall be wrapped with (rubber and friction or insulating plastic) tape in manner approved for circuit voltage.

Where conductors are to be connected to metallic surfaces, the coated surfaces of the metal shall be polished before installing the connector. Lacquer coating of conduits shall be removed where ground clamps are to be installed.

The electrical contractor shall furnish and install all hangers, racks, cable cleats and supports required to make a neat and substantial cable installation.

5.85 Identification

Each feeder conductor in a pull box or panel shall be identified by metal tag. Tags shall be 1-in. in diameter and have stamped numbers and letters ¼-in. high.

5.86 High-Frequency Systems

High-frequency system equipment and components are sufficiently different in electrical and physical characteristics to warrant a separate section in the electrical specification. System voltage and frequency; type of conductors and raceways; and ratings of equipment items should be clearly noted in definitive specification clauses. Wherever possible, manufacturers' names, catalog numbers, or other designations should be used to establish type and quality of equipment items.

To minimize increased electrical losses due to higher inductive reactance at higher frequencies, different conductor arrangements and spacings are employed. This is particularly true for heavier power loads at higher frequencies (1000 cycles and above). Such design consideration is reflected in specification selection of concentric conductors, coaxial cables, or the relatively new high-frequency busduct which adds a flexibility feature not heretofore attainable. The use of non-magnetic metal enclosures and raceways also help control electrical losses in these instances.

When standard 60-cycle control devices (fused switches, circuit breakers, etc.) are used on high-frequency systems, they must be derated to prevent excessive heating. Equipment manufacturers' recommendations in this respect must be followed. Such derating should be indicated in the specification clauses.

6.0 Branch Circuits

CHECK LIST

- ☐ **Bus Duct** — size, voltage, phase, number of conductors
  - — Plug-in type — plug-in tap-offs, capacitors, ground detectors, etc.
  - — trolley type — mobile or stationary tap-offs
- ☐ **Circuit Characteristics** — amperes, volts, phase, frequency (high frequency)
  - — air conditioning
  - — emergency circuits
  - — heating circuits
  - — lighting
  - — power
  - — special equipment
- ☐ **Conductors** — size, voltage, type of insulation
  - — armored cable
  - — concentric or coaxial (high frequency) if used
  - — mineral insulated
  - — multi-conductor cables
  - — non-metallic sheathed
  - — open wiring
  - — single conductor
- ☐ **Dimmers** — lighting circuits
- ☐ **Hazardous Location Wiring** — raceways, fittings, accessories
- ☐ **Raceways** — type and size
  - — cellular concrete floor — header ducts and fittings
  - — cellular steel floor — header duct and fittings
  - — conduit — rigid metal, EMT, flexible metal, plastic, plastic coated metal
  - — surface raceways — wireways, troughs, trays, etc.
  - — underfloor duct — metal, fibre — junctions and fittings
- ☐ **Raceway Accessories** — size and type
  - — conduit fittings
  - — outlet boxes — flush, surface type
  - — junction boxes — flush, surface type
- ☐ **Wiring Devices** — amperes, volts, number of poles
  - Switches
    - — push type, toggle, key-operated
    - — 3-way, 4-way
    - — master switch
    - — silent operation
    - — time switch
  - Receptacles
    - — single, duplex, triplex
    - — single circuit, split circuit
    - — grounded receptacles
    - — combination 125-, 250-volt, grounded
    - — circuit-breaking type
    - — special purpose
    - — twist tight type
  - Plates — switch and receptacle
    - — metal, plastic
    - — single or gang installation
    - — combination switch and receptacle and/or pilot light
    - — flush or surface type
    - — weatherproof
- ☐ **Low-Voltage Switching** — switches, relays, master switches
- ☐ **Supplementary items** dictated by specific project design

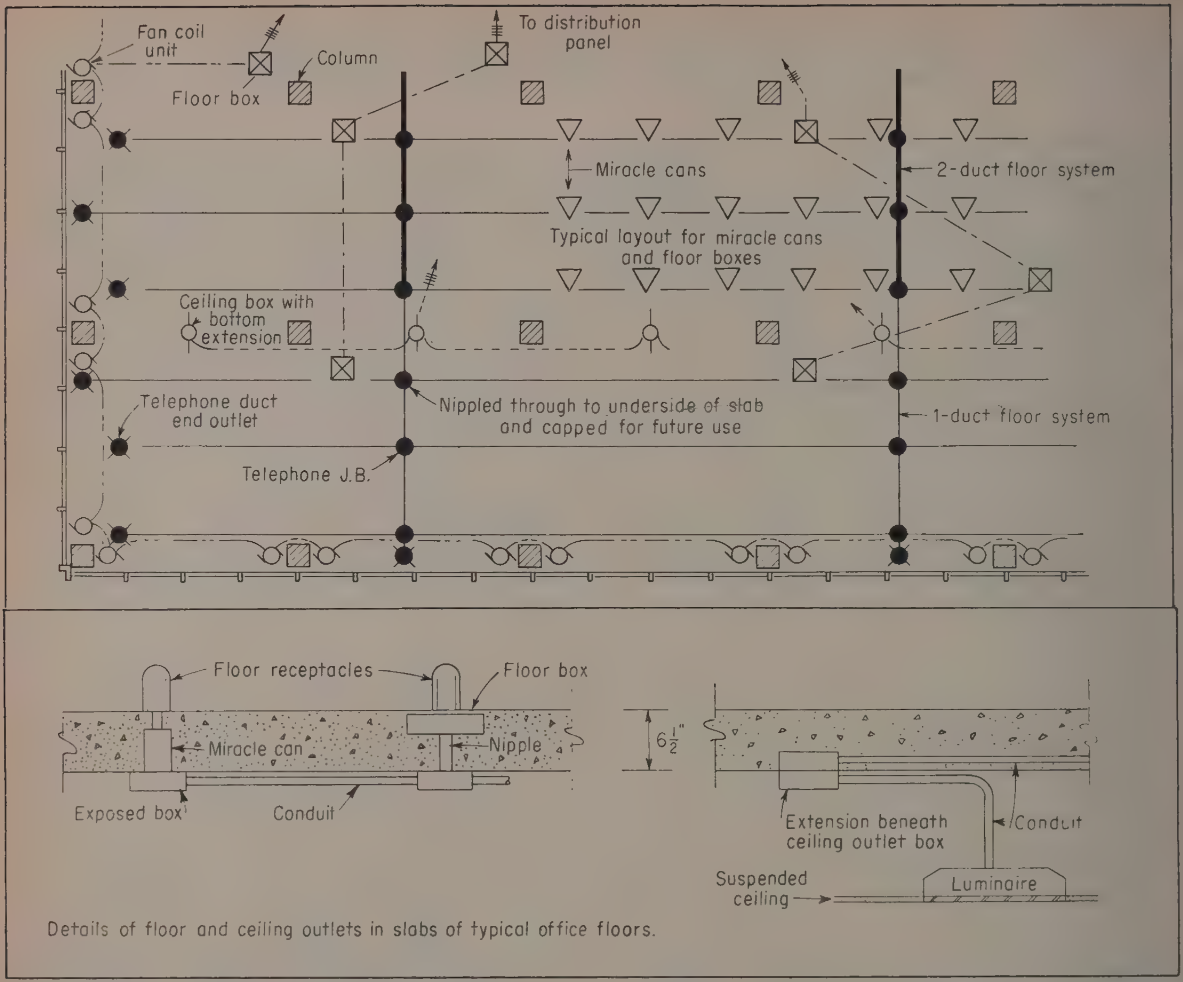
Branch-circuit design reflects the engineer's concept of adequacy, spare capacity, flexibility and accessibility. Specifications and plans should indicate clearly circuit types, voltage and phase characteristics, proposed circuit routing, type of raceway (conduit, wireways, plug-in bus-duct, trolley duct, underfloor duct, cellular floor cells, etc.), and supporting methods.

Where unusual circuiting, installation conditions or special provisions are involved, detailed drawings and separate specification clauses should be developed and incorporated in the electrical specifications.

One approach to developing a branch-circuit specification is to start with a general clause (as follows), then add relevant component clauses selected from the prototype examples presented in boldface type throughout this section.

The electrical contractor shall furnish and install all raceways, conductors (of type noted), outlet boxes, wiring devices, fittings and necessary supporting facilities for the ... volt ... phase, ... wire branch-circuit systems indicated in the plans and specifications. Equipment shall conform to requirements noted in succeeding specification clauses.

All branch circuits shall be installed as shown on the plans. Minimum size conductors shall be No. 12, Type insulation, 600 volts, except as otherwise noted.



Details of floor and ceiling outlets in slabs of typical office floors.

BRANCH-CIRCUIT LAYOUTS should be clear, concise and factual. Where unusual methods are specified, addition of detailed sketches eliminates misunderstanding on part of estimator and installation crew.

Larger size conductors shall be used where noted herein or indicated on the drawings.

Outlets shall be located as shown on the plans. Where located in paneled work or other special interior finish, they shall be properly centered. Boxes shall be of the type noted and approved for the specific application.

Wall switches of specified type and rating shall be installed as shown on the plans and shall control the outlets indicated. They shall be mounted . . . ft, . . . in. above floor level unless otherwise noted.

Receptacles shall be of the type and rating specified herein or indicated on the plans. They shall be installed . . . in. above floor level at designated locations, unless otherwise noted on the plans or in the specifications.

Conductors terminating at wired outlets shall extend at least 8 in. beyond the outlets to facilitate installation of wiring devices or fixtures. All connections shall be made mechanically and electrically secure. Splices shall be soldered, or made with approved wire connectors, and properly insulated for the system voltage.

6.1 Lighting

Depending upon the complexity of the design and installation, lighting system specifications can be all-inclusive or divided into sections relating to specific systems and techniques. In either case, it is important to indicate on the plans the type of branch-circuit raceways, conductors, number of circuits, type of fixtures (see Section 7.0), and method of control. Typical specification clauses follow.

6.11 General Lighting

Branch-circuit conductors for the general lighting system shall be installed in (specify type of raceways) from the panelboards to outlets and between outlets as indicated on the plans.

No wire smaller than No. 12 shall be used for any lighting branch circuit. If the single distance from panelboard to first outlet exceeds 50 ft, the minimum size conductor for this run shall be No. 10. If, in special cases, this distance must be exceeded, larger conductors of sizes noted on the plans shall be installed.

Outlets shall be as specified herein and shall be of a type approved for installation conditions encountered (flush plaster or dry wall, masonry construction, concrete slab, surface mounting boxes or conduit fittings).

This can be expanded, if desired, by adding typical specification clauses covering component parts and accessories noted elsewhere in this section.

6.12 Special Circuits

Where the design involves lighting other than general lighting, add clauses to define each type. This might cover, for example, show-window lighting, parking areas, private streets and drives, building or area floodlighting. Include description of control features.

Branch-circuit wiring for show windows shall be installed as noted on the plans. Circuits shall supply window lights only and shall be separately controlled by (time switch or manual switches) as indicated.

6.13 Receptacle Circuits

Furnish and install branch circuits to receptacle outlets as noted on the plans. Circuits shall be (specify conduit and wire, wireways, multi-outlet assemblies, etc.) as indicated in specific areas.

No wire smaller than No. 12 shall be used for any branch circuit supplying convenience outlets. No receptacles shall be supplied by any circuit (2-wire or 3-wire) that also serves one or more lighting outlets. For excessively long runs (50 ft or more) from panelboard to first receptacle outlet, minimum size wire shall be No. 10 with conductors between outlets being No. 12.

Receptacle circuits shall be (fuse, circuit breaker or switch) controlled as indicated on the plans.

Receptacles for specific areas shall be of the size and type indicated on the plans and specified herein.

This part of the specification can be amplified by including relevant wiring device clauses noted elsewhere.

6.2 Emergency Circuits

Specify emergency circuits as a complete system including emergency service or standby power facilities, automatic control features, feeders, panelboards, branch circuits and outlets.

The electrical contractor shall furnish and install a complete emergency lighting system, as shown on the plans, including necessary standby power equipment, control accessories, feeders, panels, branch circuits and outlets as noted.

All wiring shall be (specify conduit and wire or other method) of sizes indicated on the drawings and shall conform to the provisions of the NEC and all other local regulations covering this type of installation.

Supplement this general emergency system specification clause with the necessary relevant clauses covering equipment and accessory items.

Frequently, local or state regulations designate the number, location and wattages of lighting outlets; also types and ampere-hour or full-load capacity of auxiliary emergency systems together with minimum voltages. It is good practice to check with local authorities before designing and developing specifications for emergency equipment and wiring layouts.

6.21 Independent Sources

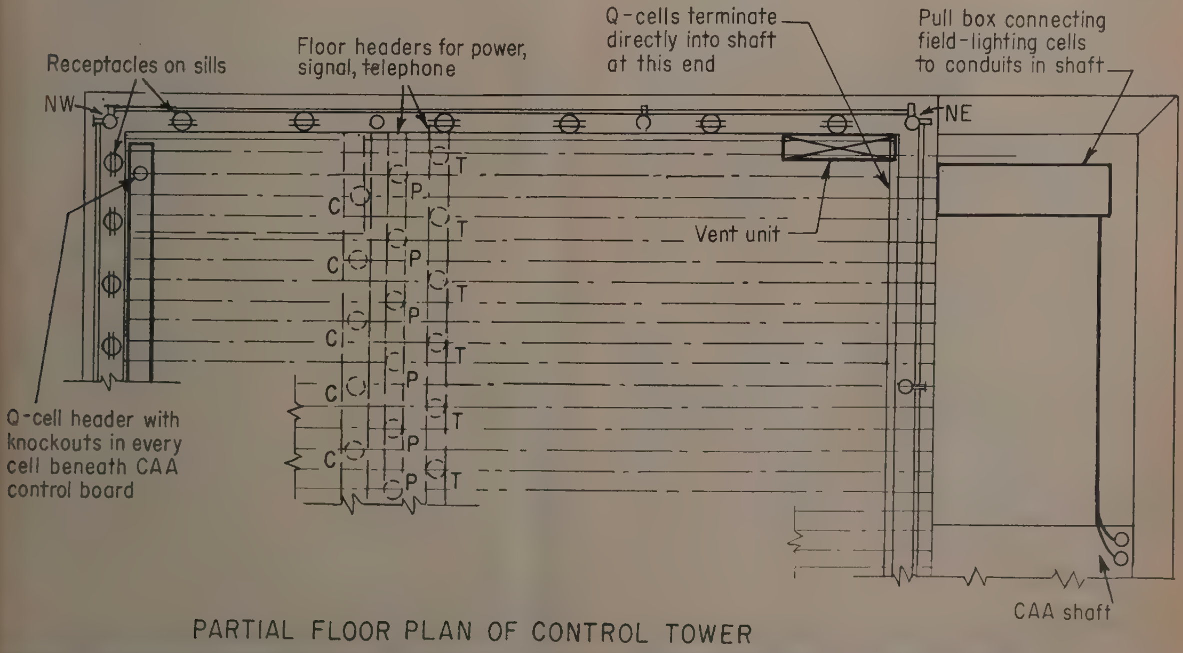
Two or more separate and complete emergency lighting systems with independent current supply. If the several supply systems also serve all or part of the general lighting system, make this clear in the plans and specifications. Also include automatic transfer equipment necessary to keep emergency lighting circuits energized in case of power failure.

6.22 Standby Generators

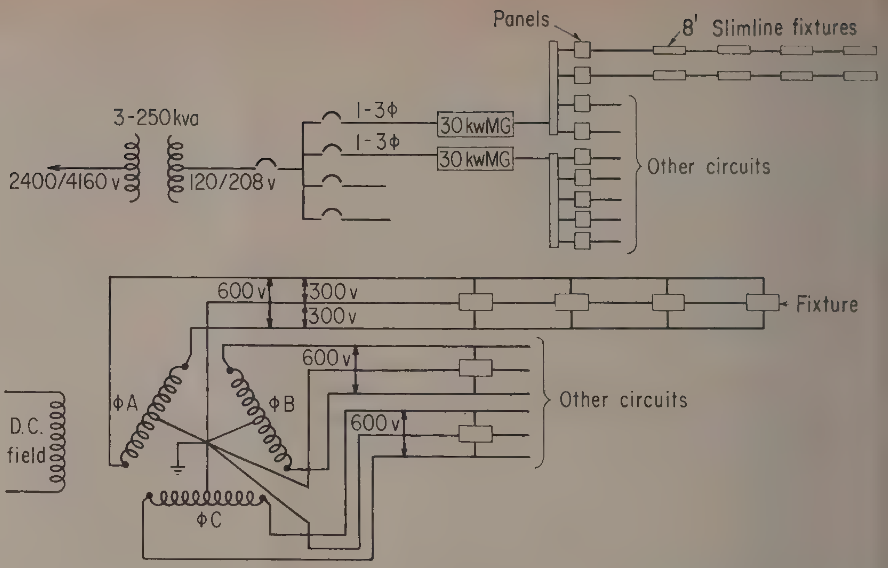
When automatically (or manually started) standby generator sets are the emergency power source, include definitive specification clauses covering such equipment and its related control. A typical specification appears in Section 2.0 Service Entrances, Standby Generator 2.131.

6.23 Storage-Battery Sets

Auxiliary storage-battery systems of approved types may be provided instead of, or in addition to, independent sources for emergency lighting systems. A typical speci-


Receptacles on sills
Floor headers for power, signal, telephone
Q-cells terminate directly into shaft at this end
Pull box connecting field-lighting cells to conduits in shaft
NW
NE
Vent unit
C
P
T
Q-cell header with knockouts in every cell beneath CAA control board
CAA shaft
PARTIAL FLOOR PLAN OF CONTROL TOWER

CELLULAR FLOOR DISTRIBUTION plan shows location and number of header ducts to be installed for "home run" access to various cells used as electrical raceways.



HIGH-FREQUENCY distribution system for lighting is clarified in simple diagrams showing basic system components and details of 420-cycle, 600-volt circuits from M-G frequency converter.

fication for this equipment appears in Section 2.0 Service Entrances, Storage Battery Sets 2.132.

6.24 Warning Signals

Approved signal devices of audible or visual type to give warning of derangement of the emergency current sources and to indicate when batteries or generator sets are carrying the emergency electrical load.

6.25 Small Battery Circuit

Small non-compulsory storage-battery system with separate circuit to small number of specially equipped lighting units located in several important areas. Circuit is fed from an automatic battery-control panel.

Control panel usually consists of an automatic battery charging device and an automatic switch or relay to turn on auxiliary lighting circuit if normal power source fails. Connection must be provided between auxiliary lighting-circuit control panel and normal supply to operate automatic transfer relay or switch and battery charger.

Give details in specifications and on plans, noting capacity and voltage of battery and nameplate information on automatic transfer switch and battery charger. List equipment number and manufacturer's name, or approved equal.

6.26 Package Units

Individual unit-equipment emergency-lighting system where a complete package unit contains lamps, storage battery, charger and automatic transfer relay. Package units are shelf- or bracket-mounted at strategic locations throughout a building and permanently connected to a nearby 115-volt circuit on normal supply. On normal supply failure, package unit automatically turns on and provides emergency light for a specified time.

Specify number, location and manufacturer's name, or approved equal, of package units to be installed where indicated on plans.

6.27 Main Service Tie

Connection to supply side of main service, if sufficiently separated electrically and physically from main service disconnect to minimize possibility of simultaneous interruption of supply.

Specify point of connection to main service, size of circuit to emergency lighting transformer and/or lighting panel; also size of disconnecting means and method of control.

6.3 High-Frequency Circuits

As previously noted in Section 5.86, separate plans and specifications should be developed for high-frequency electrical systems. Specific clauses covering branch circuits serving lighting and power equipment, as well as the equipment itself, should supplement the over-all high-frequency system specification.

Clearly indicate the following: voltage and frequency of the system; size and type of conductors (conventional wire, concentric conductors, coaxial cable, high-frequency busduct); size and type of raceway (metallic, nonmagnetic); installation instructions. Check manufacturers' and engineering research data and recommendations. Use manufacturers' designations or catalog numbers wherever possible to establish type and quality.

Where standard 60-cycle control equipment is to be specified for high-frequency use, secure manufacturers' recommended derating of units for such application and note these values in the specifications.

A typical general specification for a high-frequency lighting installation might read as indicated below.

6.31 High-Frequency Lighting

The electrical contractor shall furnish all equipment, materials, accessories and labor to install a complete . . . cycle, . . . volt lighting system for the . . . area as noted on drawing No. . . . .

From the . . . amp (circuit breaker, fused disconnect) in the . . . volt distribution center, run a 3-phase, 60-cycle circuit to each of the . . . cycle, . . . volt, frequency converters noted on the plans. Each circuit shall consist of three No. . . . , Type . . . conductors in . . . in. . . . conduit.

Install and connect the frequency converters and related control.

From each frequency converter install single-phase, . . . cycle, . . . volt circuits to the high-frequency distribution panels as noted on the plans. Each circuit shall consist of two No. . . ., Type . . . conductors in . . . in. . . . conduit.

Branch circuits from the high-frequency panels to the lighting outlets shall be single-phase, . . . cycle, . . . volt. Conductors shall be . . . No. 12, Type . . . installed in . . . conduit of size noted on the plans. Each circuit shall serve . . . fixtures as indicated. Fixtures shall be located as shown on the plans and shall be installed . . . ft, . . . in. above floor level.

6.32 High-Frequency Converters

Rotary converter sets are available as compact package units which are specifically designed to provide power to lighting systems at specific frequency and voltage values. The driving motors are conventional units for operation at conventional secondary voltages. The generators are available to provide power at the desired frequency and voltage, such as 3 phase, 600 volt, 420 cycles, 6 wire (three single-phase circuits), with 300 volts maximum to ground. Typical rotary converter specifications appear in Section 8.0 Motors and Generators.

Static-type converters are also available. One such converter is the magnetic frequency multiplier (360-cycle secondary), which has no moving parts, and can be considered as a transformer (transforming both voltage and frequency). Another is a transistorized high-frequency power source for lighting. One such unit, for example, delivers up to 1.5 kw at 1500 cycles and 150 volts peak. Manufacturers of static-type converters should be contacted for specifications covering latest developments.

A basic specification for a static frequency multiplier might read as follows.

The electrical contractor shall furnish and install, where indicated on the plans, one (specify number) static frequency multiplier(s) rated . . . kw, . . . volts, . . . cycles output. Nominal input rating shall be . . . volts, 60 cycles, 3 phase. Units shall be Model No. . . . as manufactured by . . . . . . Company, or approved equal.

6.33 High-Frequency Panelboards

Distribution panelboards for high-frequency lighting circuits are usually built to fit a specific installation design. Mains are designed to accommodate one or more single-phase feeders from the frequency converter, and branch-circuit facilities provide 2-pole, 600-volt disconnect and protective means for a specified number of single-phase, high-frequency branch circuits. A typical high-frequency panelboard specification appears in Section 4.0 Switching and Protection.

6.34 High-Frequency Busduct

The electrical contractor shall furnish and install, where indicated on the plans, a system of specially designed prefabricated, plug-in type, high frequency busduct. Busway shall be . . . phase, . . . -wire, of ampere capacities noted, and rated for operation on the . . . volt, . . . cycle electrical system. Installation shall be complete with necessary elbows, offsets, expansion sections, fittings and power take-offs to serve the indicated equipment.

Conductors shall be silver-plated, fully insulated (polyvinyl chloride jacket), multiple bars of (copper) (aluminum) spaced on very close centers with phase collection and transposition designed to equalize power distribution and provide low impedance characteristics.

Busbars, supported by insulating blocks, shall be housed in a (steel) (non-magnetic aluminum) enclosure providing (number) plug-in openings per standard 10-ft section. Sections shall be securely bolted at joints to provide maximum contact area and electrical continuity. Duct shall be supported at . . . ft intervals by approved clamps or hangers.

High-frequency busduct shall be Type . . . as manufactured by . . . . . . Company, or approved equal.

Current take-off devices shall be plug-in (circuit breaker, switch) type calibrated for the specified . . . cycle frequency; designed for use with the high-frequency busduct; manufactured by . . . . . . Company, or approved equal.

When manufacturers' technical data and catalog designations are available, the above specification clauses can be shortened by using catalog designations.

6.4 Power Circuits

Branch circuits shall be installed from power distribution panels to individual outlets, or control equipment, as indicated on the plans. Conductors shall be of the size and type noted and installed in (specify type of raceway) of size indicated or required by the number of conductors involved.

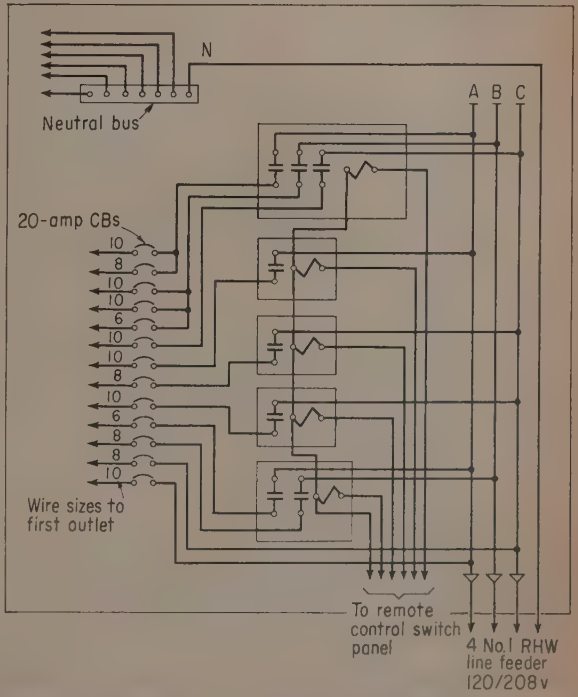
Carefully specify cable insulations, controls and raceway enclosures for each area involved.

6.41 Individual Circuits

Each motor shall be supplied by an individual branch circuit from the power distribution center (panelboard) indicated on the plans. Circuit conductors and raceways shall be of the size and type noted on the drawings.

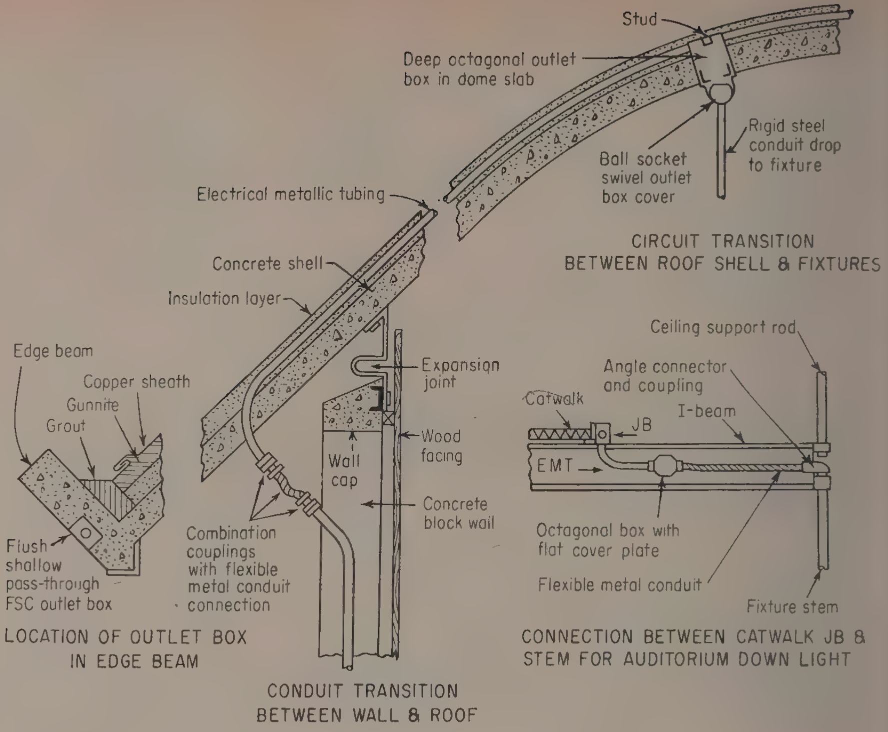
6.42 Subfeeders

Where indicated on the plans, group of motors shall be supplied by subfeeders from the distribution center.


N
A B C
Neutral bus
20-amp CBs
10
8
10
10
6
10
10
8
10
6
8
8
10
Wire sizes to first outlet
To remote control switch panel
4 No.1 RHW line feeder 120/208 v

WIRING DIAGRAM of special 5-section lighting panel with contactors simplifies field installation of specified remote control circuits. Contactors control groups of breakers serving specific circuits.

RACEWAY TRANSITIONAL details like this should supplement specifications when unusual construction is involved. Such sketches expedite estimating and installation.


Stud
Deep octagonal outlet box in dome slab
Rigid steel conduit drop to fixture
Ball socket swivel outlet box cover
Electrical metallic tubing
Concrete shell
Insulation layer
Edge beam
Copper sheath
Gunnite
Grout
Flush shallow pass-through FSC outlet box
Expansion joint
Wood facing
Wall cap
Concrete block wall
Combination couplings with flexible metal conduit connection
Ceiling support rod
Angle connector and coupling
Catwalk
I-beam
JB
EMT
Octagonal box with flat cover plate
Flexible metal conduit
Fixture stem

CIRCUIT TRANSITION BETWEEN ROOF SHELL & FIXTURES

LOCATION OF OUTLET BOX IN EDGE BEAM

CONDUIT TRANSITION BETWEEN WALL & ROOF

CONNECTION BETWEEN CATWALK JB & STEM FOR AUDITORIUM DOWN LIGHT

Subfeeders shall be brought direct to motor starters (or disconnect means) or shall terminate in a (cable trough) (bus trough) above the grouped starters with tap conductors connecting individual starters (or disconnect means). Conductors shall be of sizes indicated on the plans and troughs shall be sufficiently large to facilitate tap connections.

6.43 Busduct Taps

Motors shall be supplied by individual taps from the plug-in busduct system. Taps or bus plugs shall be provided with (disconnect switch, fuses, circuit breakers, etc., as required). Circuit shall be extended from bus plug to controller in (conduit, flexible conduit, armored cable, heavy-duty bus-drop cable, etc.) not to exceed 25 ft in length. Circuit shall be installed so that conductors and terminal connections will not be damaged by machine vibration.

The electrical contractor shall furnish and install all motor starters, pushbutton control stations, disconnect switches, thermal protective devices and fuses.

Where motor starters are an integral part of a machine, the electrical contractor shall furnish and install thermal protective devices and fuses for such units.

6.43 Heating Circuits

Specify clearly the number of heating circuits originating at a distribution center, the size and type of conductor and raceways to be installed and the number of heating units per circuit. If the heating system is extensive, a separate drawing and specification might be advisable.

6.44 Receptacle Circuits

Note specifically the phase and voltage of receptacle circuits; number, size and type of conductors; size and type of raceways; location and height of receptacle units.

Size and type of receptacles for specific use are also important. Clearly state whether they are to be single or duplex; standard or locking type; grounded or ungrounded; standard or arc-extinguishing type; 2-wire, 3-wire or 4-wire; standard, weatherproof, dust-tight or explosion-proof enclosures.

Use of manufacturer's name and catalog number, or approved equal, establishes equipment quality, facilitates identification, estimating and procurement of items.

6.5 Conductors

Economic and service conditions may dictate the use of several types of conductor insulations in a single electrical system design. Clearly indicate types of conductors to be installed in specific building areas or parts of the electrical system.

6.51 Conductors in Raceways

Unless otherwise noted, all branch-circuit conductors installed in raceways shall have 600-volt insulation of the type indicated and shall be standard AWG size. Minimum size shall be No. 12; others as shown on the plans. All wire No. 10 and smaller shall be solid; No. 8 and larger, stranded.

Conductors shall be soft-drawn copper (EC grade aluminum) conforming to ASTM specifications and latest requirements of the NEC.

Wire size, insulation type, and manufacturer's name shall be permanently marked on the conductor jacket at regular intervals.

All wire shall be delivered to the job in complete coils with an approved tag containing manufacturer's name, wire size and type of insulation.

Wire shall be color coded with a separate color for each phase and neutral used consistently throughout the installation.

Wire and cable shall be as manufactured by (name one or more companies) or approved equal.

In general, conductors with the following types of insulation shall be installed where indicated on the plans and noted below:

a. Type R (RH, RU, RUH, T, etc.) in raceways above grade in permanent dry locations.
b. Type RW (RUW, RHW, TW, etc.) in raceways exposed to moisture or in concrete slabs on fill or below grade.
c. Type AVA (AVB) in raceways exposed to extremely high ambient temperatures.

6.52 Armored Cable

Furnish and install approved armored cable for branch circuits in the . . . area or where indicated on the plans. Cable terminals shall be properly bushed at ends and securely fastened to outlet boxes with approved connectors.

At least 8 in. of conductor shall be left in boxes for splices or connection to devices.

Armored cable shall be of the best quality designed to offer a low-resistance ground path; shall be as manufactured by . . . . . . Company, or approved equal.

6.53 Non-Metallic Sheathed Cable

For all non-metallic sheathed cable branch circuits as called for elsewhere in these specifications and noted on the plans, furnish and install the indicated sizes of non-metallic sheathed cable of the . . . type with . . . insulation, as manufactured by the . . . . . . Company, or approved equal. The cable shall be approved for the type of service and installation conditions noted. Cable shall be supported every 4½ ft by . . . type straps or staples approved for the purpose.

Where cable is to be installed in wet or corrosive atmosphere, cable shall be Type NMC (moisture and corrosion resistant).

Where branch-circuit cable is shown underground (direct burial), cable shall be Type UF with Type RW, TW, RUW, or RHW insulated conductors and over-all outer covering, which shall be flame-retardant, moisture-resistant, fungus-resistant and corrosive-resistant.

6.54 Mineral-Insulated Cable

Branch-circuit conductors in the . . . areas, where indicated on the plans, shall be of the mineral-insulated, metal-sheathed type as manufactured by the . . . . . . Company, or approved equal. Cable shall be (one, two, three, etc.) conductor with a highly compressed refractory mineral insulation (magnesium oxide) encased in a continuous metal (copper) sheath. Cable shall be installed in strict accordance with manufacturer's instructions.

Cable shall be supported, at not more than 6-ft intervals, by means of approved staples, straps, hangers, or other fittings, to building structure or specially designed brackets.

At termination points, cable shall be provided with an approved seal immediately after stripping to prevent entrance of moisture into the mineral insulation. Conductors beyond the sheath shall be encased in approved insulating sleeve.

When MI cable is connected to outlet boxes, panels, or other equipment, approved fittings suitable for the service conditions shall be used. Fittings shall be of the threaded-gland type with "screw-on pot" seals filled with an insulating compound approved for the atmospheric and service conditions in which the cable is used. Fittings shall be as manufactured by the . . . . . . Company, or approved equal, and shall bear an Underwriters' label of approval.

Stripping of cable ends, installation of fittings, application of insulating compound, and actual cable terminations shall be made according to manufacturer's specific instructions.

Where MI cable is installed in hazardous locations, it is recommended that local inspection authorities be consulted to be certain that the proper terminal fittings and insulating compound approved for existing use conditions are installed.

6.6 Raceways

Specifications should clearly indicate the types of raceways to be furnished and where each is to be installed. Typical specification clauses covering a number of these systems follow.

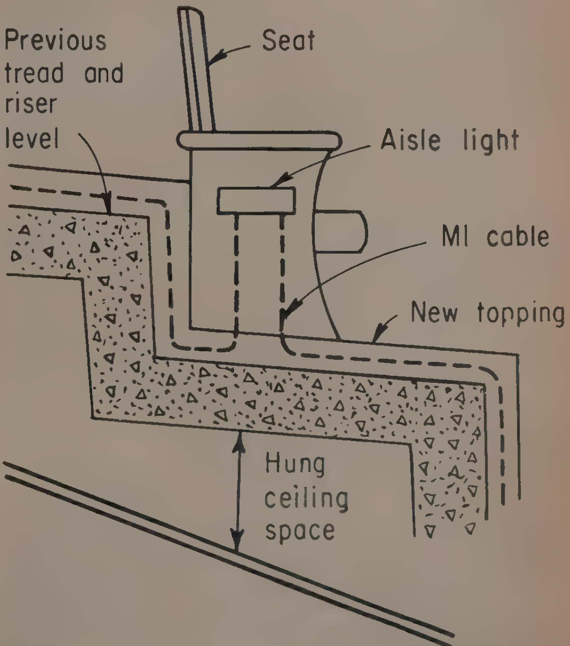
6.61 Conduit

For all conduit installations specified herein, or noted on the plans, furnish and install (select one or more types and state where each type shall be used):

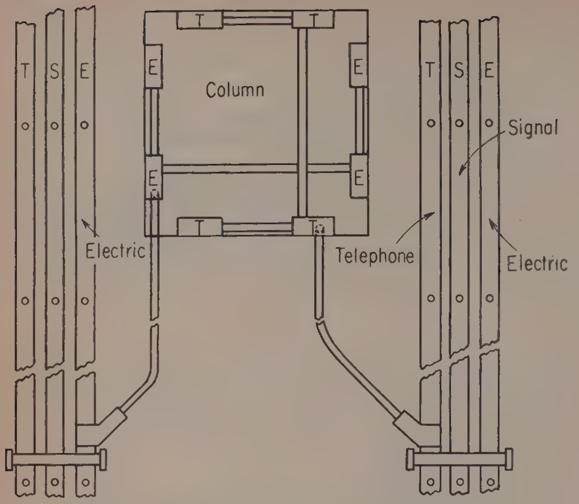
a. Corrosion-resistant rigid steel conduit
b. Aluminum conduit
c. Corrosion-resistant, non-ferrous alloy rigid conduit
d. Flexible metallic conduit
e. Plastic-coated metallic conduit
f. PVC plastic conduit (at present, UL listed for underground and concrete slab use).

Minimum size conduit shall be ¾ in., unless otherwise noted. Other sizes shall be as indicated on the plans, or required by the NEC for number and size of conductors installed.

All conduit joints shall be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets shall be



MI CABLE CIRCUITS follow contour of existing theater floor; eliminated concrete chasing in rewiring project; saved on installation costs.



COLUMN OUTLETS supplement triple-duct underfloor distribution system for office building; add to flexibility of modular concept.

made with standard conduit ells, field bends made with an approved bender or hickey, or hub-type conduit fittings. Number of bends per run shall conform to NEC limitations.

Concealed conduits shall be run in a direct line with long sweep bends and offsets. Exposed conduits shall be run parallel to and at right angles to building lines.

Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to all boxes with locknuts and bushings in such manner that each system shall be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.

All conduit systems must be installed complete before conductors are pulled in. Conduits shall be securely supported at . . . ft intervals by . . . straps, or . . . hangers, or supporting assemblies as indicated on the plans.

Conduit, elbows and couplings shall be as manufactured by the . . . . . . Company, or approved equal.

Conduit fittings shall be as manufactured by the . . . . . . Company, or approved equal.

6.62 Electrical Metallic Tubing

Electrical metallic tubing raceways as called for in the specifications and shown on the plans shall be approved type as manufactured by . . . . . . Company, or approved equal. Couplings and connectors shall be of the threadless type as manufactured by the . . . . . . Company, or approved equal. All connectors shall be made up tight. If installed in wet locations, or buried in concrete or fill, couplings and connectors shall be raintight or concretetight type, as required.

6.63 Wireways and Troughs

A. Wireways

Furnish and install wireways, complete with necessary fittings, to house branch-circuit conductors as noted on the plans and called for elsewhere in these specifications. The cross-sectional dimensions of the wireways shall be . . . in. by . . . in. Covers and knockouts shall be provided according to manufacturer's details. Wireways and fittings shall be as manufactured by the . . . . . . Company, or approved equal. All wireways, fittings and connectors shall bear the Underwriters' Laboratories' label.

Wireways shall be securely supported by approved methods at 5-ft intervals. Number of conductors per wireway shall conform to the latest edition of the NEC.

B. Troughs or Trays

Where indicated on plans, and specified herein, branch-circuit cables shall be installed in cable troughs (trays) of expanded metal (steel, aluminum) or other approved construction. Troughs (trays) and complete complement of fittings, offsets, and individual circuit outlets, shall be as manufactured by the . . . . . . Company, or approved equal. Trough (tray) system shall be securely mounted to or suspended from the building structure.

6.64 Surface Raceways

Typical specification clauses for a number of conventional surface raceway systems follow:

A. Surface Type

Furnish and install where indicated on plans surface metal raceways as made by the . . . . . . Company, or approved equal. Raceway, elbows, fittings and outlets shall be of the same manufacture and designed for use together. They shall be of a size as noted, approved for the number and size of wires indicated, and shall be installed in an approved and workmanlike manner. Runs shall be parallel or at right angles to walls and partitions. Connections shall be made to other types of raceways in an approved manner with fittings manufactured for the purpose and application.

Where combination metal raceways are installed for signal, lighting and power circuits, each system shall be run in separate compartments clearly identified and maintaining the same relative position throughout the system.

The number of conductors installed in any raceway shall not be greater than the number for which the raceway is approved.

B. Baseboard Type

Furnish and install, as indicated on the wiring plans, a system of metallic baseboard wireways for (indicate whether single raceway for 115-volt service, single raceway for telephone and signaling service, or two parallel raceways or combination raceway for two complete systems, one for 115-volt service and one for telephone and signaling services).

This system shall be installed complete with junction boxes, outlet fittings, cross-connected raceways, circuit conductors and wiring devices as indicated on plans. The system shall be as manufactured by . . . . . . Company, or approved equal.

C. Multi-Outlet Type

At locations shown on plans furnish and install a multi-outlet assembly in one or more continuous sections. These sections shall consist of a raceway with outlets to receive standard attachment plugs spaced . . . in. apart. Raceway and associated outlets shall be as manufactured by . . . . . . Company, or approved equal.

For window and cove lighting reflectors, furnish and install metal raceway or wireway assemblies containing lamp receptacles connected on circuits as indicated on wiring plans. They shall be as manufactured by . . . . . . Company, or approved equal.

D. Metal Framing

Continuous-slot, steel-channel framing, frequently used to provide support for electric lighting fixtures may also be used as a raceway for branch-circuit conductors if approved for the purpose and equipped with a closure strip.

This cold-rolled steel channel with a continuous slot comes in a square and rectangular cross section; has a nut and bolt assembly which can be inserted and tightened anywhere along the length of the slot to eliminate punching and drilling bolt holes.

When specifying this type of raceway and support system, indicate manufacturer's name and catalog designation, or approved equal, to establish size and strength of channel desired. Also indicate spacing of supporting hanger or brackets, and the need of closure strip if the channel is used as a raceway.

6.65 Plug-in Busways

Furnish and install a complete prefabricated plug-in type busduct distribution system as shown on the plans. Busway shall be . . . volt, . . . phase, . . . pole, with (copper) (aluminum) busbars of ampere capacities noted. Each 10-ft section of duct shall have (specify number) covered openings for attachment of plug-in type current take-off devices. The system shall be complete with all fittings, enclosures, insulating and supporting members as shown; shall be supported from the building structure at 5-ft intervals. System and parts shall be of the same manufacture and designed to be used together. Assembly and installation shall be made according to the manufacturer's recommendations. The busduct shall be Type . . . as made by . . . . . . Company, or approved equal.

A. Bus Plugs

Furnish and install bus plugs as listed and at the locations shown on the plans. Bus plugs shall be of the type and size designated and shall be of the same manufacture as the busduct and designed for use with it. (Specify disconnect, overcurrent protection, capacity and type of raceway or cable connection required.)

B. Bus Plug Circuits

Connections from the plug-in device to the equipment served shall be made with . . . (specify wire and conduit; flexible metallic conduit; or heavy-duty, multi-conductor, bus-drop cable). Terminations at motor control cabinets shall be so made that machine vibration will not loosen the mechanical and electrical connections.

C. Other Plug-in Units

Where indicated on the plans, and noted in the specifications, furnish and install capacitor plugs (state kva rating), transformer plugs (state kva rating), ground detector plugs, temperature indicating plugs, transposition sections, and expansion joints.

Unless the busduct system is made up of standard lengths and fittings, a manufacturer's detailed dimensional drawing for the complete system should be secured and approved before the equipment is installed. It is not advisable to cut duct sections to fit structural requirements at field locations.

6.66 Trolley-Type Busways

A. Multi-phase

Furnish and install a complete busway system, as indicated and detailed on the plans, for operation of each mobile current-collecting device. Busway shall be . . . amp, . . . phase, . . . pole, . . . volts. System shall be complete with necessary straight or curved busway sections, access sections (if necessary) for insertion and removal of trolley-type current-collecting devices, cable feed-in facilities, end closures and bumpers, and approved hangers. All parts shall be of the same manufacture and designed to be used together. Assembly and installation shall be made according to manufacturer's recommendations. System shall be . . . type as manufactured by the . . . . . . Company, or approved equal.

Furnish and install a total of (state number) current-collecting trolleys. Trolleys shall be . . . amp, . . . phase, (fused or unfused), with (sliding disc, brush, or roller) contacts and equipped (with or without tool hangers). Units shall be designed for use with the busway and provide continuous electrical contact as they move freely along the entire length of the busway.

B. Single Phase

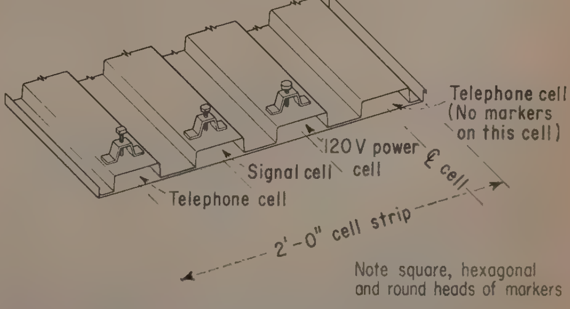
Furnish and install a single-phase, trolley-type busway system to provide branch-circuit wiring for lighting fixtures as indicated on the plans and noted elsewhere in these specifications. Busway shall be . . . amp, . . . pole, . . . volts, and shall provide continuous electrical contact for mobile, or stationary-type current-collecting devices as noted. System shall be complete with necessary fittings, couplings, feed-in devices and current take-off units. Duct runs shall be (flush, messenger cable, rod hanger) mounted and supported by approved hanger fittings at 5-ft intervals, unless closer spacing is indicated in the plans or specifications.

All fixtures shall be electrically fed and mechanically suspended from the busway with approved supports so that suspension is independent of current tap-off device.

Furnish and install a total of (number) current-tap units of the (twist-type or trolley) type as noted on the plans and listed in these specifications. Current take-off units shall be of the (terminal or receptacle) type as noted. Busway, tap-off units and accessories shall be Type . . . as manufactured by the . . . . . . Company, or approved equal.

C. Messenger Cable

Where noted on plans, furnish and install a complete messenger cable system to support the busways. Exact location of messenger cable runs shall be determined in the field. Cable shall be $\frac{3}{8}$-in. diameter, high strength, . . . strand, galvanized steel wire. Where messenger bridles are used, they shall be of $\frac{5}{8}$-in. diameter galvanized flexible steel wire. Cables shall be securely anchored to building steel with end-brackets as detailed on the drawings. Intermediate supports from roof steel structure, and wherever necessary, shall be made of $\frac{3}{8}$-in diameter bolt rod-supported by beam clamps. Maximum cable sag allowable is 1 in. with busway and fixtures in



CELL MARKERS are a vitally important specification point for cellular floor and underfloor duct systems. Note coded identification used on this project.

place. Messenger cable installation shall include all clamps, bolts, devices, turnbuckles, supports, and anchors necessary to provide a secure system.

D. Roll-in Duct

Some trolley duct lines are available with roll-in features permitting assembled duct sections to be rolled into place on pre-installed roller-type hangers from a centrally located work platform. This has particular merit when relighting areas over production machinery or similar projects.

Where roll-in duct is to be used, clearly specify same noting special hangers and accessories needed. Insert term "roll-in," "roller," or other manufacturers' designation in appropriate specification clauses above relating to duct and mounting methods. Check manufacturers' data for recommended installation techniques.

Mobile busway systems should be detailed on the plans with full and accurate dimensional information. Methods of supporting the system and circuiting to the various busway sections should be indicated clearly.

6.67 Underfloor Duct

Furnish and install a complete (metal) (fiber) underfloor duct system as shown on the plans. System shall consist of (number) ducts, of size as indicated, to provide raceways for (110-volt) (telephone) (low-tension) system wiring. All duct, fittings, junction boxes, outlets, connectors, and supporting brackets shall be as manufactured by the ...... Company, or approved equal and designed for use with this system.

Connections between the duct system and distribution cabinets and wall outlets shall be made with rigid or flexible steel conduit, or fittings specially approved for this purpose.

Duct, junction boxes, outlets, and connections shall be installed according to manufacturer's recommendations and with the best workmanship. All surface covers, where intended to be flush with the finished floor, shall be level and true. All inserts shall be sealed against entrance of moisture. Dead ends of all ducts shall be closed and sealed.

Unless otherwise indicated, all outlets for all systems shall be installed and wired complete.

Suitable markers shall be installed at the end of every line of raceway to mark the line of the duct. Suitable markers shall be installed to act as base points for locating duct outlets for future use.

6.68 Cellular Floors

A. Steel Floors

Building construction in the areas shown consists of cellular steel floor of a type approved for use as raceways for electrical conductors.

In these areas, wiring distribution for the 110-volt branch circuits, branch telephone circuits, and low-tension (any other) systems, shall be installed in the floor cells, as noted on the plans.

Furnish and install all header ducts (floor or ceiling type), end closures, feed connections, floor-covering adapters, outlets and taps as listed and shown on the plans. All duct and devices shall be as listed by the Underwriters' Laboratories for use with cellular steel floor system and shall be as manufactured by the ...... Company, or approved equal.

Cover plates, furnished by others, shall be brushed with cold-flowing compound and attached to the floor by self-tapping screws.

All junction units shall be adjusted to screed line and leveled before concrete pour. Floor-covering adapters must be of a size to conform to the thickness of floor covering to be used.

End closures shall be sealed as recommended by the manufacturers.

All fittings and outlets shall be designed for the type of floor used and be installed in an approved manner according to instructions supplied by the manufacturer.

The cellular steel floor shall be grounded at a suitable location in accordance with local regulations.

The headers, outlets, extensions from cells, etc., shall be roughed-in as a system and all wire shall be pulled after fill and finish are completed.

Install suitable markers, identifying particular cells of each system, on top of selected cells and finish flush at screed line. Extend marker through floor covering with a grommeted screw. There shall be one marker per system for every 200 sq ft of floor area, and not less than two per system per room, as directed.

A total of . . . floor taps and 110-volt (specify type) outlets shall be cut in where directed upon occupancy. These shall be wired complete, with a maximum of . . . outlets per circuit. Furnish . . . outlets, complete with taps, as spares.

A total of . . . floor taps and (specify type) low-tension floor outlets shall be cut in where directed upon occupancy. Furnish . . . outlets, complete with taps, as spares.

It is important that the header ducts and fittings specified are designed for installation with the type of cellular floor used in the building.

B. Concrete Floors

Building construction in the areas shown on Drawings No. . . . consists of pre-cast cellular concrete slabs of a type whose cells are approved for use as electrical raceways. Branch-circuit wiring for (110-volt, telephone, signal and other low-tension systems) shall be installed in the concrete cells as noted on the plans.

The electrical contractor shall furnish and install all transverse metal header ducts, panel collars, riser ducts, wall elbows, feeder duct ground strips, leveling bolts, drive plugs for outlet extensions, knockout markers and necessary outlet fittings to make a complete branch-circuit distribution system.

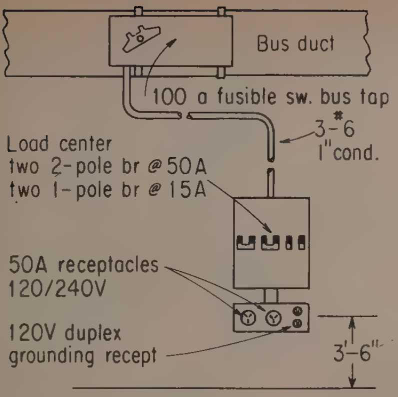
All header duct components and outlet accessories shall be listed by Underwriters' Laboratories for use with cellular concrete floor construction and shall be as manufactured by the ...... Company, or approved equal. Installation shall be in accordance with NEC regulations and manufacturer's recommendations.

Cell inserts shall be of metal and leveled to floor grade and sealed against entrance of moisture. Receptacles shall be of the grounded type, and a ground conductor shall connect receptacles to a positive ground connection provided on the header duct. All header duct joints and end closures shall be effectively sealed against entrance of moisture. Duct and cells shall be kept free of debris and foreign materials.

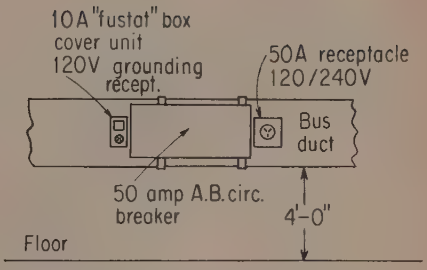
Expand the above clauses to include designation of what cells are to be used as conductor raceways, the number and spacing of inserts, receptacles and outlets to be installed at present, and the number of each type of outlet fittings to be supplied for future installation; the location and installation of suitable markers. Follow pattern of cellular steel floor specification.

6.7 Hazardous Locations

Carefully check the class of hazard against the equip-



Connections For Each Pair Of Dryer Test Stations



Connections For Each Washer Dryer Test Station

PLUG-IN BUSDUCT serves engineering and product laboratories with branch-circuit facilities detailed for local test stations.

ment listing. Secure the owner's written statement as to the type of operation to be carried on within the area, and check the design and proposed layout with inspection authorities having jurisdiction. After determining definite degree of hazard, specify equipment according to NEC classifications.

All equipment, fittings and wiring installed in the . . . area, as noted on the plans, shall be as approved by the NEC for Class . . ., Division . . . locations. Materials shall be of the best quality designed for the type of hazard indicated.

At least five full threads shall be engaged on all conduit connections to couplings and fitting hubs. Threads shall be coated with a sealing compound to make connection gas tight. Sealing fittings shall be properly installed at all required locations in accordance with code regulations.

Installation and workmanship shall be of the best quality performed by experienced mechanics to assure maximum operating safety.

Fittings shall be Type . . . manufactured by the . . . . . . Company, or approved equal.

Switches and controls, of sizes noted on the plans and specified herein, shall be as manufactured by the . . . . . . Company, or approved equal.

Lighting fixtures, as noted on the plans or listed in the fixture schedule, shall be of the type indicated and as manufactured by the . . . . . . Company, or approved equal.

The above specification clauses can be expanded, as desired, to fit the specific installation design. If necessary, more detailed information can be given for equipment items.

6.8 Raceway Accessories

6.81 Conduit Fittings

Where indicated on the plans, and noted in the specifications, outlets on exposed conduit systems shall be of the threaded-hub, cast-metal, conduit type fitting suitable for the wiring devices to be installed. Fittings shall be Type . . . as manufactured by the . . . . . . Company, or approved equal.

6.82 Outlet Boxes

All outlet boxes shall be standard galvanized-steel type, at least 1½ in. deep, single or gang type of size to accommodate devices noted. Boxes shall be equipped with plaster ring or cover as necessary.

Standard deep-type outlet boxes (concrete rings with appropriate covers) shall be used in floor-slab construction so concealed conduits entering sides of boxes can clear steel reinforcing rods.

Bracket outlets shall be located . . . ft, . . . in. above finished floor level, and centered on columns or above doors when installed in these locations.

Wall switch outlets shall be set . . . ft, . . . in. above finished floor. When located near doors they shall be at a height of . . . ft, . . . in. and installed on the lock side of the door.

Clock outlet boxes shall be installed . . . ft, . . . in. above the floor, or a height to meet architectural conditions.

Outlet boxes for concealed telephone and signaling systems shall be of the 4-in. square type with plaster cover and bushed-opening (⅜ in.) cover plate. Telephone wall outlet boxes shall be set flush . . . in. above floor level, unless otherwise noted. Signal system outlets shall be set flush in the wall . . . in. above the floor level, as indicated on the plans.

Boxes for floor outlets shall be of the cast-metal, threaded-conduit-entrance, waterproof type with means for adjusting cover plate to finished floor level. Boxes shall be approximately 4 in. in diameter and 3½ in. deep, with an approved gasket or seal between adjusting ring and box.

Cover plates on floor boxes shall be of heavy brass with permanent ring or flange and rubber gasket. Plates shall have . . . in. diameter threaded hole in center for installation of a flat plug or fitting for receptacle or other type of outlet as indicated by symbol on plans.

Outlet boxes shall be as manufactured by the . . . . . . Company, or approved equal.

Watertight floor boxes shall be as manufactured by the . . . . . . Company, or approved equal.

6.83 Junction or Pull Boxes

Furnish and install junction or pull boxes in the raceway system where necessary to facilitate conductor installation.

All boxes shall be made of galvanized steel, of metal gauge and physical size as required by the NEC for the number and size of conduits and conductors involved. Boxes shall have removable screw covers for (flush) (surface) installation as indicated on the plans.

Boxes shall be securely mounted to the building structure with supporting facilities independent of the conduits entering or leaving the boxes.

Where junction or pull boxes are to be of unusual design or size, more detailed specification clauses and/or plans might be required.

6.9 Wiring and Control Devices

Specify wiring and control devices according to manufacturer's catalog number to establish quality standard. Note pertinent electrical ratings of each. Typical clauses follow.

6.91 Receptacles

a. Standard duplex receptacles shall be (manufacturer's name) No. . . ., or approved equal, rated . . . amp, . . . volts, with (T) (parallel) slots in a rugged plastic housing and with (screw) (screwless) terminals arranged for (side) (back) wiring.

b. Split-circuit duplex receptacles shall be (manufacturer's name) No. . . ., or approved equal, with the (top, bottom) half of each receptacle arranged for switch control while the other remains energized at all times. Rating shall be . . . amp, . . . volts.

c. Triplex receptacles with parallel slots shall be (manufacturer's name) No. . . ., or approved equal, rated at . . . amp, . . . volts and equipped with side-wired terminals.

d. Duplex grounding-type receptacles shall be (manufacturer's name) No. . . ., or approved equal, rated at . . . amps, . . . volts. Receptacles shall accommodate either standard 2-wire plug or 3-wire grounding-type plug.

e. Combination 125- and 250-volt duplex receptacles shall be manufacturer's name) No. . . ., rated at . . . amps, . . . volts. Slot configuration of the high-voltage side shall differ from the low-voltage side so attachment plugs cannot be interchanged.

f. Fan hanger receptacles, where indicated on the plans, shall be installed . . . ft, . . . in. above floor level. Receptacle shall be (manufacturer's name) No. . . ., or approved equal.

g. Clock receptacles shall be (manufacturer's name) No. . . ., or approved equal, rated at . . . amps, . . . volts.

h. Where indicated by symbol on the plans, receptacles shall be of the locking type wherein the matching connector cap cannot be pulled from the receptacle until the locking feature is disengaged. Receptacles shall be rated . . . amps, . . . volts and shall be (manufacturer's name) No. . . ., or approved equal.

i. Special-purpose receptacles shall be of the capacity (amps, volts) and design (2- or 3-wire, grounded, ungrounded, polarized, etc.) as indicated on the plans. Receptacles shall be (manufacturer's name) No. . . ., or approved equal, designed to receive connector caps of appropriate rating and polarity only.

j. Combination receptacle, switch and/or pilot light devices shall be (manufacturer's name) No. . . ., or approved equal, with (2-wire, 3-wire grounded) outlet rated . . . amps, . . . volts and switch rated . . . amps, . . . volts.

6.92 Switches

a. Standard flush tumbler switches shall be (manufacturer's name) No. . . ., or approved equal, "T"-rated . . . amps, . . . volts, unless otherwise noted. Switch mechanism shall be enclosed in a stable composition or ceramic housing with (screw) (screwless) terminals arranged for (front) (side) (back) wiring.

b. Switches indicated by appropriate symbol shall be lock-type, key-operated, rated . . . amps, . . . volts and shall be (manufacturer's name) No. . . ., or approved equal. Furnish . . . spare keys.

c. Mercury switches for silent operation shall be (manufacturer's name) No. . . ., or approved equal, flush tumbler type rated . . . amps, . . . volts.

d. Silent operating toggle switches of standard mechanical type shall be (manufacturer's name) No. . . ., or approved equal, rated . . . amps, . . . volts.

e. Where indicated on the plans, flush toggle switches for control of 2-speed air conditioning, fan or blower motors shall be the maintained-contact, 3-position, 2-circuit type rated . . . amps, . . . volts, single or double pole as noted. Switches shall be (manufacturer's name) No. . . ., or approved equal.

f. Switches controlling or disconnecting motor loads in excess of ⅓ hp shall be horsepower rated and approved for motor control service. Switches shall be (manufacturer's name) No. . . ., complete with overload device of proper rating.

Switches shall be single-pole, double-pole, 3-way or 4-way as indicated by the drawing symbols.

Where more than one switch is shown at an outlet, switches shall be installed under a gang plate in an order appropriate to outlet location.

Where switches are to be other than toggle type, such as push (tap operated), rotary, rocker-arm, weatherproof lever-operated, etc., specify same by one or more manufacturer's catalog numbers to establish type and quality.

6.93 Low-Voltage Control

With low-voltage control, circuit switching is performed by relays whose coils are operated by momentary contact switches connected to a low-voltage supply. Prototype specification clauses for such a system are noted below. Paragraphs marked "a" are for sequence systems, paragraphs "b", "c", "d" or "e" for positioning systems.

Outlets and circuits indicated by the appropriate symbol on the plans are controlled by a remote control low-voltage relay system.

A. Relays

Furnish at each outlet indicated a relay installed in a box knockout and connected in an approved manner.

Furnish and install at each location where indicated a remote control relay cabinet complete with the number of relays shown. The relays shall be installed in barriers which effectively isolate the circuit conductors from the low-voltage control wiring.

B. Switches

Switches indicated by the appropriate symbol are low-voltage remote control type.

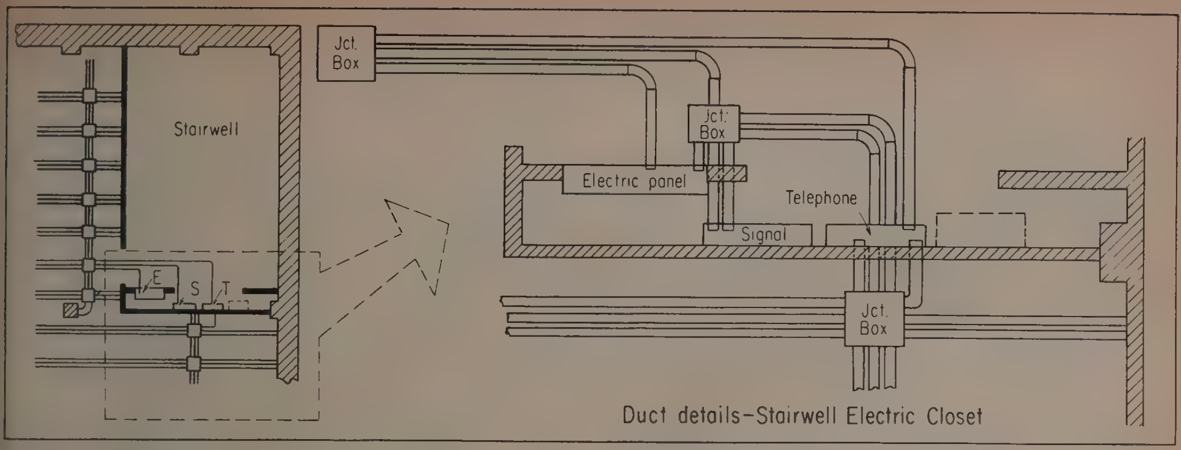
Furnish and install at each switch outlet one or more, as indicated, momentary contact low-voltage switches of an approved type designed specifically for low-voltage remote control switching service and for the system employed.

a. Switches shall be 2-wire, single-pole, normally open, to operate sequence "on-off" relays.

b. Switches shall be 3-wire, single-pole, two-position, normally open.

C. Master Switch

a. At master switch location furnish and install a multiple switch assembly for master switch service. Each switch shall operate the outlet or circuits indicated and shall be wired to parallel the local switch. Pilot lights associated with each button shall indicate when the relay is in "on" position.



SECTION BLOWUP of underfloor duct system terminations insures panel connections will be made as intended by system designer.

b. At master switch locations shown, furnish and install a combination switch and selector. Manual rotation of the selector shall connect the switch to operate each of the outlets or circuits controlled. The appropriate selector terminals shall be wired to parallel the local switches.

c. At master switch locations shown, furnish and install a multiple switch assembly with master control. Each of the "individual" switches shall operate independently of the others except that operation of the master control will position all of the associated relays in the "on" or "off" position simultaneously.

d. Switches shown as master switches shall operate a remotely controlled, electrically operated master unit. When pressed in the "on" position, the unit shall momentarily close all "on" contacts of the circuits controlled. In the "off" position, the unit shall momentarily close all "off" contacts.

e. Switches shown as master switches shall operate a remotely controlled, electrically operated master selector switch. When pressed in the "on" position, the selector shall sweep the "on" contacts of the outlets and circuits controlled. In the "off" position, the switch shall cause the selector to sweep the "off" contacts.

D. Pilot Lights

Furnish and install, where shown, low-voltage pilot lights of a type specifically designed to operate with the low-voltage, remote control system.

E. Power Supply

Low-voltage power for relay operation shall be provided from separate transformers specially designed for the service and for the system installed or from an individual low-voltage source incorporated in the relay device.

Transformer characteristics and installation shall conform with the requirements of Article 725–Remote Control, Low Energy Power and Signal Circuits, NEC.

a. (DC operation) The power supply for relay operation shall include converters or rectifiers to provide dc operating current to the relays. Rectifiers shall be of a type specially designed for the service and the system and shall be enclosed within the relay cabinet.

The low-voltage remote control system components and accessories shall be as manufactured by the ...... Company, or approved equal.

Conduit, raceways, junction and outlet boxes for the low-voltage control circuits shall conform with the specifications for Signal and Communications System.

Conductors and cables shall be of the size and type designed for the system or recommended by the manufacturer. Multi-conductor cables shall contain identified conductors, and circuits shall be wired to maintain consistent and uniform identification.

6.94 Dimmer Control

Where lighting branch circuits are to be dimmer controlled, specify make, type and rating (range) of dimmer equipment to be installed. A typical specification for a simple system might read:

Furnish and install where shown on the plans a ...... Company No. ... (stepped) (continuously adjustable) dimmer control for the (incandescent) (fluorescent) lighting circuits indicated. Dimmer shall be rated ... volts, (watts) (number of 40-watt fluorescent rapid-start lamps).

More detailed specifications should be developed for the more extensive and more sophisticated equipment needed for heavier and more complex load control. Refer to manufacturers' technical literature and catalog material.

6.95 Central Control

Where specific circuits or lighting areas are to be controlled from a single point, specify the size and type of magnetic contactors to be installed. Indicate number of poles, ampere and voltage rating of contactors and if they are to be individually mounted or grouped in a cabinet. Control points and circuits involved should be clearly indicated on the plans.

6.96 Time Switches

Where specific lighting circuits are to be controlled by time switches, note specific type of switch dial required and specify switch by one or more manufacturer's catalog numbers, or approved equal, to establish quality.

6.97 Plates

Furnish and install wall plates of appropriate type and size for all wiring and control devices, signal and telephone outlets. Plates shall be (composition, steel, brass, etc.) of ... thickness. (Add color, finish and special markings as required.)

When devices are installed in exposed conduit fittings or outlet boxes, the plates or covers shall be of a type designed for the fittings or boxes.

7.0 Lighting

CHECK LIST

☐ **Circuit Characteristics**
  — voltage
  — phase
  — frequency
  — multiple
  — series

☐ **Fixtures To Be Furnished**
  — by others
  — by electrical contractor

☐ **Optional Equipment** — procedure for submitting alternates

☐ **Drawings**
  — general layout
  — details of special fixtures
  — details of special mounting
  — details of special arrangement

☐ **Fixture Schedule**
  — master for whole project
  — individual for each area and each plan sheet

☐ **Installation**
  — mounting height
  — spacing between units
  — type of suspension
  — surface mounting details
  — recessed troffer types
    — saddle-supported with ceiling flange
    — snap-in type for ceiling channels
  — pole, bracket or wall mounting (outdoor units)

☐ **Control Methods**
  — standard switch or panel
  — centralized remote
    — standard voltage
    — low voltage
  — automatic control
    — time clock
    — photoelectric relay
    — dimmer, manual or automatic

☐ **Fixture Details**
General
  — light source
    — incandescent
    — mercury-vapor
    — fluorescent
    — integrated light and air type
  — construction
  — finish
  — wiring
  — shielding media
  — number of lamps
Component Parts
  — ballasts
  — fusing (heating, overcurrent)
  — sockets
  — other pertinent accessories

☐ **Luminaire Classification** (based on light distribution)
  — direct
  — semi-direct
  — direct-indirect (general diffuse)
  — semi-indirect
  — indirect

☐ **Emergency Units**
  — night lights
  — exit lights
  — directional lights

☐ **Hazardous Area Units**
  — dust-ignition-proof
  — enclosed and gasketed
  — explosion-proof

☐ **Outdoor Lighting Units**
  — floodlighting and area lighting
  — street and highway lighting
  — protective lighting

☐ **Other items** pertinent to lighting design

Ultimate success in attaining the desired lighting results requires that all light sources and lighting equipment be furnished and installed exactly as selected and specified. To insure that this is done, the designer (architect, engineer) should prepare a set of detailed lighting specifications complete with lighting plans and detailed drawings where necessary.

Lighting equipment normally is classified under two broad headings: 1) Luminaires—individual lighting fixtures or units, etc.; and 2) Lighting Equipment—components and lighting devices such as wiring channels, strip lighting, cove lighting, diffusing panels, louvers, etc. (other than luminaires).

All luminaires (for fluorescent, incandescent or mercury-vapor light sources) may be classified under one of five basic types, based on their respective light distribution characteristics: 1) Direct—D; 2) Semi-Direct—SD; 3) General Diffuse or direct-indirect—G; 4) Semi-Indirect —SI; and 5) Indirect—I.

Standard specification paragraphs for the basic types of luminaires (for specific light sources) can be prepared easily by the specification writer, or can in most instances be obtained from the manufacturers of such luminaires A number of typical specifications will be presented in this section.

Lighting equipment other than luminaires varies so widely in types and application that no attempt will be made here to provide prototype specification clauses for such equipment. When such items (cove lighting, special fixtures or luminaires, etc.) are to be furnished and installed, the specifier should detail the equipment on the drawings and prepare special specification paragraphs which describe the equipment in detail.

The five basic types of luminaires mentioned above vary widely in quality, design and physical appearance, mechanical features, materials, metal thicknesses, brightnesses, finishes, etc. For this reason, the specifier should give a specific detailed indication of the exact luminaires selected for each area of the lighting project. This may be done under any one of the following methods:

Performance

Describe the lighting result or illumination performance wanted from the luminaires.

Many engineers have considered this type of specification, but it is seldom used because of the difficulty experienced in writing a suitable, workable specification. It is not covered in this section.

Description

Give a description of the physical and photometric (light distribution) features of the exact luminaires wanted.

The descriptive specification is preferred over the performance type as a means of indicating luminaire selection to meet definite detailed structural standards and light-distribution standards. It has the advantage (where this is desirable) of not mentioning a specific product by name and leaves it up to the various manufacturers to prove their products meet the detailed requirements of the descriptive specification.

Prime disadvantage of this method is that it makes it somewhat more difficult for an electrical contractor to identify standard catalog items with the specifications when estimating the job or when ordering equipment unless the manufacturer produces assurances that his product meets the specifications.

Catalog Number

Use a lighting equipment manufacturer's name, trade name and/or catalog number to designate the exact luminaires wanted.

Designation of a manufacturer's trade name and/or catalog number to identify and establish luminaire quality is apparently the method preferred by a majority of engineers on private projects. As noted in numerous specifications, such clauses are short, concise and direct. They simplify a contractor's estimating and equipment purchase chore. An engineer's knowledge of and experience with one or more manufacturers' products leads him to use this method of establishing quality standards for specific luminaires.

The listing of two or more trade names, or the addition of an "or approved equal" clause, lifts the specification out of the "proprietary" class and permits normal competition. The specifications should definitely indicate which authorized person makes the final decision as to equality of equipment submitted for approval and the required steps for submitting alternate items.

Choice of method of specifying lighting equipment lies with the specification writer and should reflect the engineer's, architect's and/or owner's wishes. Both methods will be illustrated with typical clauses in this section.

7.1 General Conditions

General conditions for the Lighting section may include a number of specific items covered under General Conditions for the entire electrical specification (see Section 1.0). This may include such subjects as scope of work, materials and substitutions, workmanship, finishes, wiring and tests.

7.11 Scope of Work

State definitely in the specification who is to furnish the specified luminaires or lighting equipment. This can be included in a clause, as noted below, or reference can be made to the electrical specifications General Conditions (Section 1.12).

The electrical contractor shall furnish all luminaires, lighting equipment and components shown on the plans, listed in the "Fixture Schedule," and specified herein. He shall furnish all labor and materials to install the specified equipment in the manner indicated.

All luminaires and lighting equipment shall be delivered to the building complete with suspension accessories, canopies, hickeys, casings, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes, etc., all wired and assembled as indicated.

The electrical contractor shall furnish and install lamps and accessory wiring as indicated under the general provisions of the electrical specification.

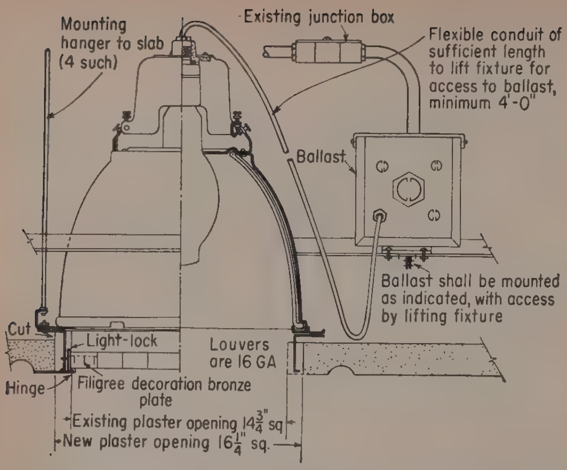
7.12 Drawings

When special lighting equipment, other than standard catalog items, is specified, detailed drawings should be called for (see also Section 1.13), as follows:

Full-size shop detail drawings of special luminaires or lighting equipment, where called for in the specifica-

FIXTURE SCHEDULE

Type	Location	Quantity	Description	Lamps per Fixture				Mounting Height	Remarks
				No.	Type	Watts	Color		
A	Office	72	(Name), Cat. No. ______	2	96T12 Slimline		Cool White	10′–0″	Stem suspension
B	Factory	450	(Name), Cat. No. ______, RLM Type ______	2	40WT12 Rapid Start		Daylight	14′–0″	On continuous channel
C	Shipping	24	(Name), Cat. No. ______	1	Incand.	100	White	14′–0″	Self-aligning stems


Mounting hanger to slab (4 such)
Existing junction box
Flexible conduit of sufficient length to lift fixture for access to ballast, minimum 4'-0"
Ballast
Ballast shall be mounted as indicated, with access by lifting fixture
Cut
Light-lock
Louvers are 16 GA
Hinge
Filigree decoration bronze plate
Existing plaster opening $14\frac{3}{4}$" sq
New plaster opening $16\frac{1}{4}$" sq.

DETAILED DRAWING clarifies prescribed supporting techniques for high-bay mercury-vapor fixtures and ballasts in a bank relighting project; supplements specification data.

tions, shall be submitted to the architect (engineer) for approval. When approved, they shall be returned with contract authorizing fabrication of equipment to be furnished.

7.13 Materials and Workmanship

Statement to the effect that all materials shall be new and of best grade and of approved manufacturing standards. All workmanship to be first-class and resultant product to be of the high-quality type and finish as specified.

7.14 Finishes

Statement indicating manufacturer's standard finish, or details on special finishes wanted as noted in the specifications or Fixture Schedule.

7.15 Luminaire Wiring

Insure safe fixture wiring with a paragraph similar to the following:

Luminaires with medium-base sockets shall be wired with no smaller than No. 16, and mogul sockets with not smaller than No. 14, Type AF asbestos-covered wire in accordance with latest requirements of the current edition of the NEC.

Fluorescent luminaires shall be wired with not smaller than No. 16 Type AF asbestos-covered wire. No splice or tap shall be located within an arm, stem, or chain. Wire shall be continuous from splice in outlet box of the building wiring system to lamp socket, or to ballast terminals.

LIGHTING SYSTEM CLASSIFICATION

Type	Symbol	Lighting Distribution	
		UPward Component	DOWNward Component
Direct	D	0–10%	90–100%
Semi-Direct	SD	10–40%	60–90%
General Diffuse	G	40–60%	40–60%
Semi-Indirect	SI	60–90%	10–40%
Indirect	I	90–100%	0–10%

All fluorescent ballasts, as indicated, shall be of the high-power-factor type and their design and construction shall conform to the CBM Standards.

7.16 Optional Equipment

Many architects and engineers name two or three fixture manufacturers in the lighting specifications whose equipment represents the type and quality desired. Others name one and that's it. Still others, for valid reasons include the "or approved equal" option.

Current trends favor base bids covering specific listed equipment to establish a benchmark for bid comparison. Then everyone is bidding on an equal basis.

If, however, quotations on alternate or optional equipment are to be permitted in the original bid, or at a later date, the exact basis on which such proposals are to be handled should be spelled out in detail in the specification. These proposals should conform to the statements and procedures covered in paragraphs 1.62—Specification by Brand Name, and 1.63—Material Substitution, under Section 1.0 General Conditions.

If provisions for Optional Equipment set forth in the specifications covering lighting equipment are meant to supersede General Conditions, this fact should be explicitly noted at the head of the relevant specification clauses.

The following typical specification clauses cover substitution of lighting equipment. Select, and use as a guide, the paragraphs relevant to the current situation.

a. The original bid shall be based on furnishing and installing the luminaires or lighting equipment as specified.

b. The following clauses shall supersede (supplement) relevant clauses in General Conditions section of the electrical specifications.

c. With the original bid, the bidder may, if he so desires, submit an alternate proposal based on furnishing and installing luminaires or lighting equipment other than that specified. This alternate proposal shall contain detailed information (manufacturer's trade name and/or catalog number, construction details, data on light distribution, etc.) on the proposed substitute equipment and any price differential which would apply.

d. Within (ten) days after award of the contract, the successful electrical contractor may make a written request to substitute comparable lighting equipment for that specified. Such an alternate proposal should clearly indicate any price differential which would apply; also detailed information on the proposed substitute equipment to permit a careful comparison with original specifications (luminaire construction, light distribution, etc.).

e. Any proposals for substitution of lighting equipment shall further meet all requirements of the provisions contained in paragraph 1.63 under Section 1.0 General Conditions of the electrical specifications.

f. Approval of specific lighting equipment substitutions shall be obtained in writing from the (architect, engineer, owner) before equipment is ordered. Contractors seeking substitution of optional equipment shall be in a position to furnish samples of both specified and alternate equipment for comparison, if required.

7.2 Installation Details

Such installation details as type of mounting, distance between fixtures, mounting height of units, positioning of units, etc., have a very definite bearing on the final illumination intensity and coverage of the lighting system. This means that the equipment must be installed exactly as specified.

Specifications should include clear, concise installation instructions giving pertinent dimensional data, supporting details and any other information considered essential to assure proper installation. Types of lighting units and their installation may vary in different areas of a specific building. Where this occurs, separate instructional paragraphs for specific areas would facilitate estimating and field installation.

Relevant paragraphs from Section 6.0 Branch Circuits may be used as reference, or separate paragraphs may be added to the lighting specifications. For example:

All type (identifying letter on plans) fixtures in the . . . area (or see Fixture Schedule) shall be installed in continuous rows on . . . ft centers. Bottoms of fixtures shall be . . . ft, . . . in. above floor level. Fixtures shall be mounted to (continuous-slot metal framing, trolley duct, angle or channel-iron supports, messenger cable, etc.) suspended from (or fastened to) structural steel at . . . ft intervals.

7.3 Fixture Schedule

A preferred method of identifying a variety of luminaires on plans is to assign an identification letter (A, B, C, D, E, etc.) to each specific type and incorporate this identification in the luminaire specifications and in the Fixture Schedule.

A Fixture Schedule is a comprehensive listing, in capsule form, of all lighting fixtures to be installed, plus pertinent information relating to each.

Schedule headings can be (reading from left to right): Type (A, B, C, etc.); Location; Quantity; Description (manufacturer's catalog number, etc.); Lamps (number, type, wattage, color); Mounting Height; Remarks (type of mounting, suspension, circuiting, etc.).

Fixture Schedules can be included in the pages of the specifications or placed on the plans as a supplement to specification clauses. In most cases, it is found on the plans, generally as a separate sheet listing all fixtures for the entire project. Frequently, these schedules are used as a basic guide for ordering lighting equipment.

Instead of showing one all-inclusive fixture schedule, some engineers include a smaller schedule on each sheet of the lighting plans. Such schedules list only the equipment to be installed in the area covered by that specific plan sheet. This approach eliminates the necessity of referring back to a master schedule each time lighting for a new area or floor is estimated or installed.

Whichever approach is used, the combination of an identifying symbol and a fixture schedule simplifies specifying a variety of luminaires.

7.4 Luminous Ceilings

Most luminous ceiling installations, classified as a direct (D) lighting system, are custom designed for a particular application or a specific job. Generally, standard lighting components are combined to compose the finished job. Specifications for this type of lighting should be custom prepared to meet the existing solution and existing installation conditions.

For specification purposes, ceilings formed of louvers (plastic, aluminum, steel, wood, glass, etc.) are usually placed in this category. For all practical purposes, their construction, lighting characteristics and installation details are similar. For large-area self-contained units, consisting of housings, lamps and accessories, and diffusing medium, these may be treated similar to recessed lighting troffers or other individual type of lighting units.

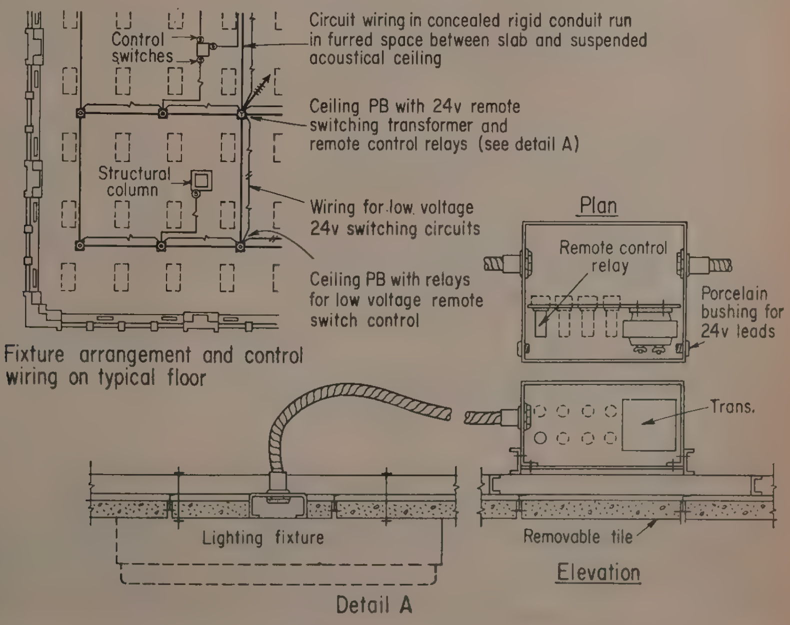
Some system designs have the T-track grid or other supporting elements of the diffusing medium (glass, plastic, etc.) suspended from the electrical channels housing the wiring and lamp sockets. This design feature permits full integration of all parts of the lighting system by one sub-contractor under one contract responsibility. Where the large-area, self-contained panel units are used, complete with metal housing and diffusing media, this problem is solved automatically through full job jurisdiction by one contractor (electrical).

Drawings should indicate, as far as possible, all details of construction and installation. These should be supplemented by complete written specifications to insure full quality of workmanship and materials as desired. Being an integral part of the structure, the architect or engineer should consider detailing most of the component parts as well as layout on the architectural, mechanical and electrical plans.

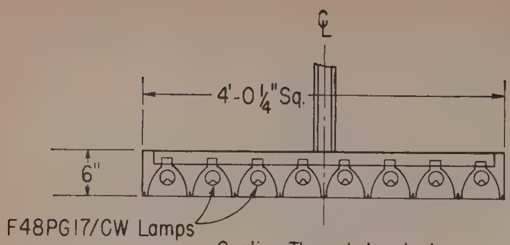
7.41 Luminous Ceiling Specification

Detailed drawings may be supplemented by the following or similar specification clauses modified as required by structural or other conditions on any specific installation.

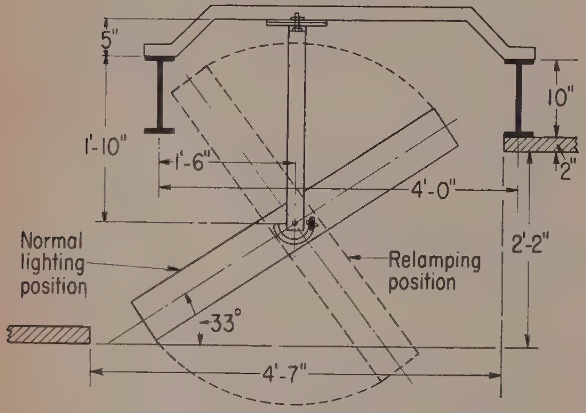
The electrical contractor shall furnish and install all


Control switches
Circuit wiring in concealed rigid conduit run in furred space between slab and suspended acoustical ceiling
Ceiling PB with 24v remote switching transformer and remote control relays (see detail A)
Structural column
Wiring for low voltage 24v switching circuits
Ceiling PB with relays for low voltage remote switch control
Fixture arrangement and control wiring on typical floor
Plan
Remote control relay
Porcelain bushing for 24v leads
Trans.
Lighting fixture
Removable tile
Elevation
Detail A

GOOD PLANS like this go hand-in-hand with good specifications. Here, fixture arrangement, circuiting and low-voltage remote-control details give mechanics thorough installation story.



Section Through Luminaire



Method and Details for Mounting Luminaires

SPECIAL MOUNTING instructions for custom-built luminaire are supplemented by detail installation sketch giving pertinent dimensional data.

wiring, wiring channels, housings, mounting frames and plastic (glass) diffusing panels for the luminous ceiling as called for in these specifications and as detailed on the drawings.

Method of assembly is shown on drawing No. .... Vinyl-resin flexible plastic sheets (or acrylate corrugated plastic panels—give details) shall be held in place by T and U shaped channels formed of not less than No. 20-gauge steel, chemically treated to prevent corrosion, and provided with a high-temperature baked white-enamel finish. The projections supporting the plastic sheets shall have a 1-in. horizontal width as shown in the drawings. Channels shall be spaced as shown on drawing No. ..., and suspended as indicated by wire or adjustable metal straps in a manner that will maintain straight and level position.

Acoustical control, where called for, shall be obtained by the use of hollow perforated white-enameled metal fins (outline in detail any other method developed and wanted) containing a sound-absorbing pad. Fins shall be supported at ... ft intervals from the U channels as shown and detailed on the drawings.

Lighting wireway channels and housings shall be installed in the plenum (space) above the suspended plastic ceiling so that fluorescent lamps will be ... in. above the plastic panels. Housings shall be supported from building slab by metal rod supports as shown on drawings. Spacing between lamp housings shall be ... in. as indicated.

The suspended ceiling T and U bars shall in turn be supported from the wireway channels and lamp housings (building structure) by steel straps (rods) as shown. Contractor shall submit shop detail drawings indicating exact construction and gauges of metal housings, supports, etc.

Automatic sprinkler heads may also be mounted in the plenum above vinyl-resin plastic sheets, as listed by UL, and by the NBFU. Where acrylic plastics are used for diffusers, sprinkler heads may be mounted in U channels specifically designed for this purpose, or in suspended ceiling areas provided by the architect in the lighting layout design, or incorporated in the acoustical baffles (or otherwise as designed).

For acrylate plastics in corrugated, flat or molded patterns, and for metal or wood louvers, heavier supporting T bars and U channels should be used.

7.5 Special Lighting Fixtures

Modern lighting system design often incorporates luminaires or component equipment of a special nature. Generally, fixtures of this type are not standard catalog items permitting simple identification or description. Even if they are catalogued, their application may be of such a specialized nature that additional descriptive material should be included in the electrical specifications. This would supplement any sketch or drawing illustrating the lighting concept.

Drawings should indicate type and size of structural components, over-all physical appearance, dimensions, light-distribution data, installation details.

Pertinent information can be included in a detailed descriptive specification or in a condensed version incorporating any available catalog data. If more than one trade is involved in equipment installation, it is important to indicate who does what.

7.51 Integrated Light-Air Diffusion Fixtures

The need for increased lighting levels and air conditioning loads in commercial buildings has created a competition for ceiling space to house the lighting fixtures and air diffusers. This problem has been resolved by development and availability of special fluorescent troffers which combine engineered light distribution and engineered air diffusion in a single fixture.

Fixture designs incorporate one or more metal housings to provide air diffusion from the center or around the edges of the fixture body; and for use with low-, medium- or high-velocity air-circulation systems. Light control is by means of reflectors, louvers, or enclosing lens elements (glass, plastic, etc.). Air control is by means of a damper mounted in the air inlet at the top of the fixture and adjustable from the bottom of the fixture. Fixtures are available in a variety of flange arrangements to accommodate the type of ceiling system being installed.

In addition to electrical and photometric characteristics, fixture selection is based on such air-distribution data as cfm capacity, sound level, pressure drop, etc. Both lighting- and air-system factors must be considered.

Manufacturers of these integrated fixtures have comprehensive catalog and technical data relating to their specific units. Check this data carefully before selecting and specifying the desired units. Fixtures are designed and produced for use with air-flow assemblies of selected air-distribution equipment manufacturers. This may be a simple assembly to attach to the top of the lighting fixture, or include the major portion of the second (air flow) housing for the entire fixture. While this equipment normally is included in the air-conditioning contractor's specifications and is furnished by him, the electrical contractor should check to see if the assemblies furnished are of the proper type for the fixtures to be installed. The air-system contractor's mechanics install the air-control assemblies and air-duct connections to the lighting fixtures. This procedure has been resolved by agreement between equipment manufacturers and the respective trade unions.

Fixture Specification

Fixture selection and specification is influenced by a combination of lighting- and air-system factors. With a knowledge of the specified air-distribution system, the electrical engineer can use data contained in the fixture manufacturer's technical and catalog sheets to select units producing the desired results. Catalog numbers designate fixtures with various lighting and air diffusion characteristics.

Specifications should also include: system voltage; number, size and type of lamps; type of ballasts; type of mounting flange to match ceiling system; diffusing medium, (glass, plastic) lens, (metal, plastic) louvers, etc. Also spell out what parts of the combination unit are under the installation jurisdiction of the electricians and sheet-metal workers.

A typical specification for integrated light-air diffusion fixtures might read as follows:

The electrical contractor shall furnish and install, where indicated on the plans, integrated lighting and air diffusion fixtures of the type noted. Fixtures shall be . . . . . . Company, (trade name), Catalog No. . . . (specify one or more manufacturer's designations) with . . . type mounting flange.

Units shall be . . . ft by . . . ft for (number), . . . watt fluorescent lamps with individually (protected) (fused) high-power-factor CBM certified ballasts for operation on the . . . volt system.

Light output shall be controlled by (metal) (plastic) louvers, or (removable) (hinged) frames containing (glass) (plastic) lens panels as indicated.

Fixtures shall be designed for use with . . . . . . Company air-diffusion assemblies to be furnished by the air-conditioning contractor.

Electricians shall install the fixture body, reflector and lamp housing, lamps, make electrical connections, and install louvers or lens panels. Sheet-metal workers shall install the air-diffusion assemblies and make tubing connection to air duct. Air-conditioning contractor personnel shall adjust fixture air dampers to balance air distribution.

7.52 High-Frequency Luminaire

When luminaires are to be connected to circuits of higher frequency than standard 60-cycle, be sure that the specified ballasts are designed for operation at the frequency and voltage to be used. A statement to this effect in the appropriate luminaire specification should suffice.

7.6 Luminaire Specification

Comparative examples of preferred methods of specifying luminaires are presented below. The first is the somewhat lengthy "descriptive" specifications; the second, the shorter "catalog number" version. Both cover commercial-type luminaires of the semi-direct (SD) design. The third is a variation of the catalog designation method using the new RLM Type Numbers, for industrial fixtures, recently developed by the RLM Standards Institute.

Choice of method depends upon the specification writer (architect, engineer), his knowledge of and/or experience with standard catalog equipment and the method of handling approval of optional equipment.

7.61 Descriptive Specification

Luminaires for the . . . area, shall be of the semi-direct type such that approximately (10% to 30%) of the light output is in the 90° to 180° zone, and (60% to 90%) in the 0° to 90° zone. Luminaire shall be pendant (or surface) mounted. The over-all efficiency in percent of bare-lamp lumens shall not be less than (76%). The maximum brightness at any angle within the shielded zone shall not exceed 650 footlamberts. Molded styrene resin (acrylate plastic, or diffusing glass) panels in combination with not less than No. 22-gauge durable etched and lacquered aluminum (or steel) louvers, finished in high-temperature baked white enamel, shall constitute the shielding assembly. The louver assembly shall be a removable unit, firmly supported from the wiring channel and hinged from either side for simple and easy maintenance.

Wiring channel, reflectors, cover, and end plates shall be of not less than No. 20-gauge steel, chemically treated to resist corrosion and finished in high-temperature white baked enamel. All exposed metal-reflecting surfaces shall have a reflection factor of not less than (80%). Luminaires shall be designed for individual or continuous row mounting, and shall be for two (three, four) standard Type F fluorescent lamps (rapid start 40-watt, or Type T-12 slimline, fluorescent lamps) as indicated on the drawings and listed in the Fixture Schedule.

All wiring shall be not less than No. 16 Type AF fixture wire. Ballasts shall be of the high-power-factor multi-lamp type meeting the Certified Ballast Manufacturers' standards. Starters (omit starters for rapid start and slimline lamps) shall be of the lock-out manually reset type. Entire luminaire and all component electrical parts shall be listed by UL as meeting NEC requirements.

7.62 Catalog Designation

a. Fixture A (Schedule Symbol)—Commercial-type (slimline) lighting unit with (two or four; as indicated) 96-in. 430-ma lamps per 8-ft section. Unit shall be provided with glass side panels, "egg-crate," hinged-bottom metal louvers with white baked-enamel finish. Over-all efficiency of the 4-light unit shall be not less than . . . % when mounted on the ceiling.

Where indicated for emergency or night-light use, the ballasts shall be arranged to permit control of one lamp separately from remaining lamps.

Ballasts in each unit shall conform to the Certified Ballast Manufacturers' standards.

Fixtures shall be as manufactured by the . . . . . . Company, Type . . . Catalog No. . . ., or approved equal.

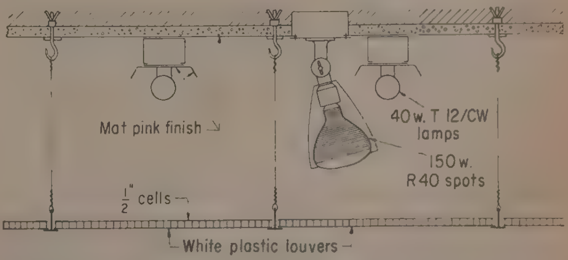
b. Or, a simple listing as follows:

Type A—(Manufacturer's name), Type . . ., Catalog No. . . ., with four 96-in. T-12 slimline lamps per fixture.

Include specification for individual fixture fusing where desired.

7.621 RLM Type Designation

To simplify specification of industrial luminaires, RLM (Registered Luminaire Manufacturer) Standards Institute, Inc., has recently assigned a new "type number" to luminaires meeting their established standards. Each



SECTION THROUGH a louvered ceiling cavity shows positioning of fluorescent strip units and adjustable incandescent accent units. Notations on finish indicate color-correction technique.

number automatically covers the complete fixture including number, size and type of lamps, ballasts, reflectors, etc.

For example: a 4-ft, 2-lamp, fluorescent semi-direct industrial luminaire meeting RLM Standard SD-1 now is identified by the RLM designation SD-1-B. This means that the unit: has a white porcelain-enamel reflector; accommodates two 40-watt, T-12 48-in., medium bi-pin base lamps; has a ballast for a rapid-start circuit and 430-ma lamp current.

To select and specify luminaires on this basis, the engineer consults his current issue of RLM Standard Specifications and finds the RLM Type number covering the units he wants. He merely specifies the appropriate RLM Type number and manufacturer's name (from the Standards) and manufacturer's catalog number (from manufacturer's literature or catalog).

A prototype specification might read:

Fixtures marked (. . .) on the plans or in the Fixture Schedule shall be RLM Type . . ., ... Company, Catalog No. . . . (designate one or more manufacturer of equipment) (or approved equal).

7.63 Direct-Type Luminaires

Where practically all of the illumination on the working plane is directed from luminaires in angles below the horizontal, a direct-type (B) fixture is specified. The following paragraphs suggest typical points to be considered in writing specifications for this equipment.

Fixtures should be included in the Fixture Schedule even if supplementary written specifications are provided.

7.631 Industrial Fluorescent

Specification (or catalog designation) should cover the following: number, size and type of lamps, type of Certified ballasts (high power factor, rapid start, Power Groove, etc.); type of RLM reflector noting percent upward component of light desired; reflector finish; whether reflector is to be open or equipped with louvers for additional shielding; whether units are to be explosion-proof, etc.; type of mounting; fixture wiring (for single or continuous row installation).

One specification arrangement follows:

Fixture B—Industrial type (slim-line) unit with (two, three) 40-watt, 430-ma lamps as indicated. Unit shall be RLM Type . . . arranged for continuous mounting; shall be as manufactured by . . . . . . Company, Catalog No. . . . or approved equal.

7.632 Industrial Incandescent

Specifications (descriptive or catalog designation) should cover the following luminaire features: size of lamp; reflector contour (standard or shallow dome, bowl, symmetrical or angle, flat cone, etc.); whether or not a diffusing globe, cover glass, or guard is necessary; steel or aluminum reflector construction; porcelain enamel, aluminum or Alzak aluminum, prismatic or mirrored glass reflecting surface; socket, reflector and hood assembly details; mounting details. Generally a catalog designation or RLM Type No. is sufficient to specify a fixture containing the desired features—including dust-ignition-proof and explosion-proof types. All fixtures should meet RLM design requirements.

7.633 Commercial Fluorescent

A majority of this equipment application is of the recessed troffer type. Specifications and/or catalog designation should indicate the following: number, and size, and type of lamps; type of ballasts; whether troffer is to be snap-in type, or flange type with supporting harness; whether it is to be open type or equipped with drop-out louvers (metal, plastic) or have hinged frame containing diffusing medium (plastic, glass, etc.); also type of finish; type of installation (individual or continuous row).

7.634 Commercial Incandescent

Accent units to be installed separately or in combination with fluorescent lighting system. Note whether recessed or the surface type. Give catalog number covering type of housing required for lamp size indicated; or write descriptive specification noting size, type and finish of housing, diffusing medium, lamp size, and other pertinent details.

7.635 Mercury Vapor

Specifications for mercury-vapor equipment should cover: size of lamp, type of reflector (medium, wide spread, concentrating); reflector construction (steel, aluminum, prismatic or silver-mirrored glass) and reflecting surface finish (porcelain enamel, etc.); socket and hood construction (vented, non-vented); open or glass-covered reflector; and other pertinent features. Generally, a single catalog designation will cover a specific unit.

Mercury-vapor reactor or transformer equipment is not integral with the fixtures and must be mounted at or near the fixtures. Specifications should give mounting details for such accessory equipment to supplement data on the electrical plans. Relevant notes pertaining to this and any fixture lowering devices (for any high-bay units where indicated) can be added in the "Remarks" column of the Fixture Schedule.

7.636 Reflector Lamps

No separate reflector or luminaire is required where reflector lamps, of the incandescent or mercury-vapor type, are indicated in a lighting system. Such lamps have a self-contained reflector in the bulb itself and frequently are used in non-hazardous areas where the atmosphere contains considerable smoke, dirt, or dirty non-explosive fumes. They are less costly to maintain because there is no reflector to catch contaminants.

Such lamps do require a mogul screw-shell socket assembly and a mounting or suspension arrangement which should be detailed on the plans.

Reflector lamps should be specified by wattage and bulb designations as provided by the lamp manufacturers.

7.64 General Diffuse Luminaires

General diffuse luminaire classification (G) covers direct-indirect units which provide illumination of a general diffuse character by having almost equal amounts of light emitted from the top and bottom of the fixture (40% to 60% up, 40% to 60% down). To attain this result, fixtures are normally suspended at various distances from the ceiling. When this type of unit is surface-mounted it can be classified as semi-direct (SD) since the reflected ceiling component is reduced.

Luminaire specifications should include: number, size and type of lamps; type of side panels (plastic, glass); type of bottom louver section (metal, plastic, etc.) and whether of hinged or drop-out type; degree of shielding desired; type of finish; type of ballast (high power factor, Certified, etc.); type and length of hangers or suspension facilities. Whether unit is for separate or continuous row installation should also be indicated.

A single catalog designation can be used to specify a particular unit, or descriptive specification paragraphs can be written.

7.65 Semi-indirect Luminaires

Luminaires in the semi-indirect (SI) classification provide from 60% to 90% of their light output from the top of the fixture (above the horizontal). These, too, must be pendant-mounted from the ceiling. Some luminaires with direct-indirect (general diffuse) design and structural characteristics, but with four to six lamps, will—because of their wider top opening—meet the zonal distribution requirements of the semi-indirect classification. Care should be taken that the bottom shielding medium will confine maximum brightness within prescribed limits.

Specifications should cover all the pertinent facts enumerated for the general diffuse units (Section 7.64). In like manner, a catalog designation can be used to specify a particular luminaire, or descriptive specification paragraphs can be written.

7.66 Indirect Luminaires

Indirect luminaires provide from 90% to 100% of their light output from the top of the fixture (above the horizontal). The light is diffusely reflected from the ceiling and side walls. Length of pendant suspension is important to the lighting result and must be carefully specified. Some fixtures with plastic enclosures may provide a greater downward light component than noted above, but still be considered in the indirect classification.

Specifications similar to those for semi-direct or direct-indirect units can be used with an additional paragraph covering the (metal, plastic, etc.) reflector medium.

7.7 Emergency Lighting Units

Lighting units for emergency systems may include any size, shape or design within the limits set by local or other applicable codes. Check those regulations before specifying units. Fixtures may be individual units (exit lights, illuminated directional signs, etc.) or may be combined with general lighting luminaires (night lights, emergency lights) but served by emergency circuits.

Specification paragraphs can be written for each type of emergency lighting unit with a clear statement that these units are to be connected to the emergency circuits noted elsewhere in the electrical specifications.

Emergency lighting units should be listed in the Fixture Schedule and detailed on the drawings to indicate any unusual construction or installation features.

7.8 Hazardous Area Lighting

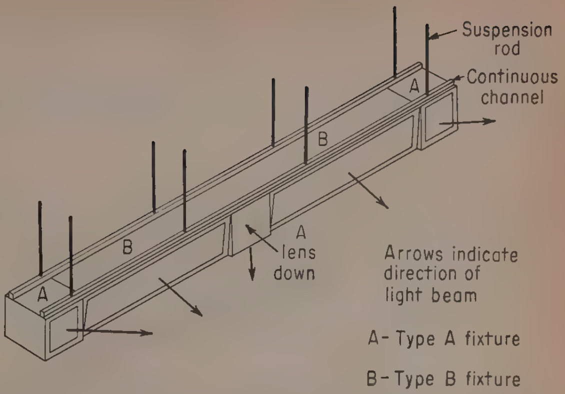
Selection of lighting equipment for hazardous areas in a specific installation should be based on NEC classifications for the degree of hazard determined by local inspection authorities. Once this is established, code recommendations should be followed and properly designated equipment specified as required. It is good practice to have on file manufacturer's detailed specifications of equipment involved.

To insure that the selected equipment is furnished and installed, the lighting equipment specification should include manufacturer's name, catalog number and a general description of the item. Several manufacturers can be listed or an "approved equal" clause can be added to conform to competitive requirements.

7.9 Exterior Lighting

Many types of outdoor lighting equipment are available for floodlighting buildings, outdoor recreational, storage and parking areas, protective lighting, and street and highway lighting. Luminaire selection is based on the construction and light output (type of beam, photometric performance) characteristics of the specific unit and the physical characteristics of the area to be illuminated.

No attempt will be made here to provide standard specifications for all types. There are too many. Instead, major points to be covered by a specification will be mentioned and followed by a selected number of typical specification paragraphs which can be modified.



SPECIAL FIXTURES or specified combinations of units are illustrated by drawing showing intended installation method. When sketches accompany specifications, contractor can accurately estimate installation cost.

A luminaire or fixture specification should include: lamp size (watts) and type (incandescent, mercury-vapor, fluorescent); type of circuit (voltage, multiple or series, etc.); fixture construction (enameled steel, aluminum, open, closed, etc.); type of beam (medium spread, wide spread, narrow or concentrating, etc.); finish of reflecting surface; type of mounting (pipe, pole, wall, cross-arm, etc.). If a lowering device is required, specify same.

In most cases, a catalog designation will suffice to indicate a fixture incorporating all the features desired. Luminaires should also be given a plan symbol and listed in the Fixture Schedule, preferably in a separate group. In like manner, outdoor lighting specifications should be separate from interior lighting specifications.

Where outdoor lighting units are to be automatically controlled, specify type control (time clock, photo-electric relays, etc.) and location. Do the same for any ballasts, transformers or other accessories required.

The following specification clause could apply to all units. This would be followed by individual paragraphs for specific fixtures.

The electrical contractor shall furnish and install floodlight (street lighting) units of the type and size indicated on the drawings, listed in the Fixture Schedule, or specified herein. All luminaires shall meet NEMA design and photometric standards.

7.91 Floodlighting

Fixture (fixture schedule symbol) shall be ...... Company, Type ..., Catalog No. ..., or approved equal, for operation with (size, incandescent, mercury-vapor, fluorescent) lamp on ... volt circuits. Units shall be mounted ... ft above the ground on (steel, aluminum, concrete) poles or on building walls, as indicated on the drawings and in the Fixture Schedule. Ballasts or transformers (where required by fixture type) shall be installed as indicated on the drawings; and shall be ...... Company, Type ..., Catalog No. ..., or approved equal.

7.92 Street Lighting

The above skeleton specification can be modified as needed to indicate specific types of street lighting units. Additional information relating to multiple or series circuits should be included. Or, more detailed specifications for this type of luminaire can be secured from the equipment manufacturers.

Add pertinent clauses about type of control equipment, mounting details.

8.0 Motors, Generators and Controls

CHECK LIST

☐ **Motors and Generators**
Equipment to be furnished, set, connected
- by owner
- by other contractor
- by electrical contractor

☐ **Type**
- direct current
- squirrel cage
- wound rotor
- synchronous
- motor-generator set
- special type

☐ **Characteristics**
- voltage
- phase
- frequency
- horsepower
- amperes, full-load
- speed
- torque
- NEMA design letters
- enclosure (open, drip-proof, splash-proof, explosion-proof, etc.)
- special characteristics

☐ **Installation**
- on machine
- on sliding base
- on foundation
- method of coupling
- connection details (terminal box, flexible conduit, etc.)

☐ **Other items** pertinent to specific design and application

☐ **Controls**
Equipment to be furnished, set, connected
- by owner
- by other contractor
- by electrical contractor

☐ **Type**
- disconnect, starter, controller
- manual
- magnetic
- line voltage
- reduced voltage
- integral control
- remote control
- accessory switches (limit, pressure, float, etc.)
- plugging switches
- timing devices
- reversing
- NEMA type enclosure

☐ **Characteristics**
- voltage
- phase
- number of poles
- ampere capacity
- protection

☐ **Installation**
- at machine, on wall, on special rack
- in a group (give details)
- in a control center
- remote control units and relays
- connection details (between control unit and motor)

☐ **Other items** pertinent to specific control system

Specifications for motors and generators and the related control equipment should cover the following considerations:

1. Who is to furnish the equipment; who is to set or mount it; and who is to install or connect it.
2. What are the physical characteristics, sizes, ratings and performance capabilities of the equipment.
3. What particular installation requirements are involved—mounting details, connecting methods, protective guards, type of coupling to machines, etc.

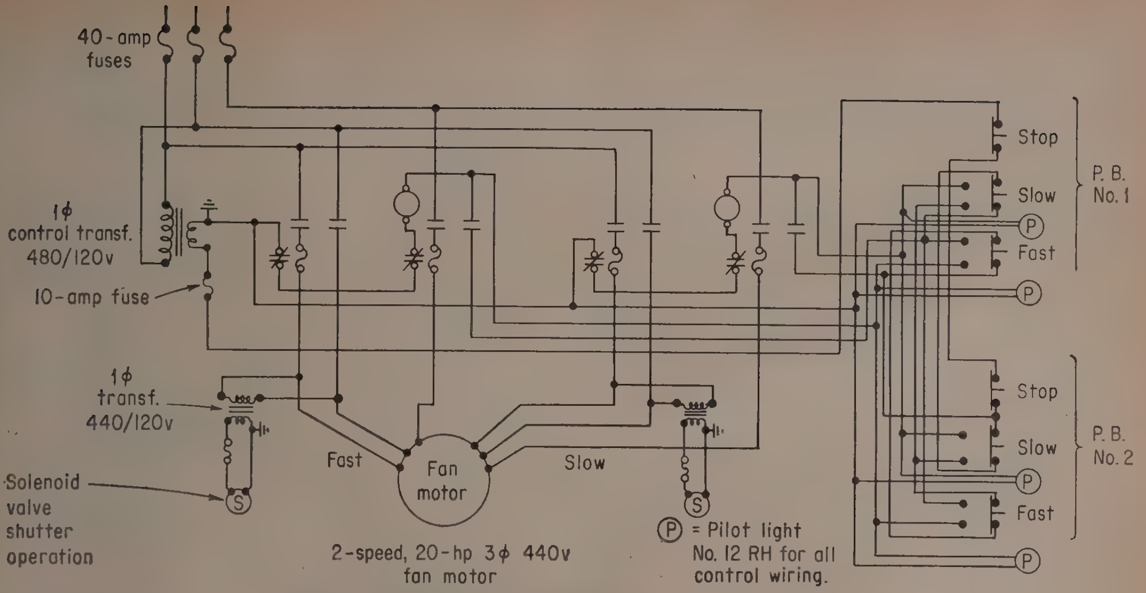
The amount of specification detail covering the installation of motors, generators and their controls will depend upon how the first of the above considerations is resolved.

Where the equipment is to be furnished by others but installed as part of the electrical contract, the specifications should cover size of equipment plus data on the circuits and other devices to be furnished and installed by the electrical contractor.

When equipment is furnished as part of the electrical contract, specification clauses should clearly and completely describe the equipment. In all cases, however, the specifications should contain sufficient detailed information to complement the data given in the electrical plans and clarify any points open to possible question.

8.1 Furnishing Equipment

State definitely who (owner, machinery manufacturer, other subcontractor, electrical contractor) furnishes the various motors, motorized equipment, generators, motor



CONTROL WIRING FOR SUBSTATION VENTILATION

REMOTE CONTROL of a 2-speed ventilating fan motor is detailed in connection diagram to facilitate installation and operation of pushbutton stations and accessory control devices.

controllers, associated control devices and disconnect switches. This may also be covered under Section 1.0—Scope of Work 1.12.

The electrical contractor shall furnish and install all electric motors and controllers as shown on the plans; also a disconnect switch for each motor where indicated; also the required feeders and control circuits, as indicated on the plans.

8.2 Installing Equipment

If the motors and controls are to be furnished by "others" (not the electrical contractor) the specifications should clearly state who is to receive, handle, set, mount and install such equipment. The idea is to establish a definite starting point for motor work covered by the electric wiring contract.

All motors and controls to be furnished by (name, others) shall be delivered to the receiving dock at the job site. Unless otherwise noted, the electrical contractor shall receive, handle, set, mount and install this equipment where indicated on the plans including all necessary feeder, control and protective circuits.

8.3 Motors

Motor specifications, per se, seldom are found in an electrical system specification. Equipment manufacturers generally select and furnish motors to match the requirement of their equipment. However, system design engineers can—and do—include general specification clauses establishing definite limits as to size and type of motors for specific areas and/or circuit voltages.

8.31 General Specification

Motors smaller than ½ hp shall be designed for operation on . . . volt, single-phase, 60-cycle circuits.

Motors ½ hp and larger shall be designed for operation on . . . volt, 3-phase, 60-cycle circuits.

Motors installed in areas where the ambient temperature will be 40°C, or less, shall have Class A insulation as a minimum.

Motors installed in areas where the ambient temperature will exceed 40°C shall have Class B insulation as a minimum.

Motors shall be as manfactured by . . . . . . Company, or approved equal, and shall meet the requirements of the latest NEMA Motor Standards.

8.32 Specific Motors

When it is necessary to write specification clauses for individual motors, there are a number of pertinent facts and data that should be considered and included in the specification. These are noted below under relevant headings.

Direct Current

Manufacturer's type and frame designation, horsepower output, time rating, temperature rise, rpm at full load, voltage, full-load amperes and winding—shunt, compound or series, in addition, type of insulation and bearings.

Polyphase Squirrel-Cage

(Also to describe ac single-phase motors.)

Manufacturer's type and frame designation, horsepower output, time rating, temperature rise, rpm at full load, frequency, type of insulation, type of bearings, number of phases, voltage, full-load amperes and "code" designation of locked-rotor kva per horsepower.

NEMA design letters for integral-horsepower motors—locked-rotor and breakdown torques; locked-rotor current; and percent slip at rated load.

Polyphase Wound-Rotor

Cover items given above for polyphase squirrel-cage motors, plus secondary amperes at full load and secondary voltage.

Synchronous Motors

Revolving field (rotor) or stationary field (stator).

Manufacturer's type designation and frame number.

Horsepower output, time rating, temperature rise, rpm at full load, frequency, number of phases, voltage, rated amperes per terminal, rated field current, rated exciter voltage, rated power factor and torques (percent of rated full-load torque)—locked rotor, pull-in and pull-out.

Universal Motors

Manufacturer's type and frame designation, horsepower output, time rating, rpm at full load, voltage, full load amperes and frequency (60/dc is recommended form).

Applications

General-purpose; definite purpose; or special-purpose motor.

Mechanical Protection

Also describe type of enclosure: drip-proof; splash-proof; semi-protected; protected; drip-proof fully protected; open externally ventilated; open pipe-ventilated totally enclosed non-ventilated; totally enclosed fan-cooled; explosion-proof; dust-ignition proof; waterproof totally enclosed pipe ventilated.

Speed Characteristic

Constant-speed; varying-speed; adjustable speed; adjustable varying-speed; multi-speed.

Miscellaneous Data

Efficiency; power factor; service factor; various torques—full load, locked-rotor, pull-up, breakdown, pull-out, pull-in.

8.33 Motor Specification

Motors for operating (......) shall be of the polyphase squirrel-cage induction type rated for ... hp, ... volts, ... phase, ... cycles, ... rpm, NEMA design (A, B, C, D, E, F,) with Class ... insulation and ... bearings. Enclosure shall be (open drip-proof, splash-proof, fan cooled totally enclosed etc.) for ... degree C continuous temperature rise, with (normal or quiet) operation. Frame number shall be ... with the following dimensions: ....

8.4 Generators

Where generators are to be included in the electrical specifications, the following data should be included in the clauses describing the units.

Direct Current

Manufacturer's type designation and frame number, kilowatt output, time rating, temperature rise for rated continuous load, rated speed in rpm, voltage, rated current in amperes, winding—series, shunt or compound, excitation voltage, or self-excited and recommended value of resistance for rheostat for hand or regular control of output.

Alternating Current

Manufacturer's type designation and frame number, kilovolt-ampere output, power factor, time rating, temperature rise for rated continuous load, rated speed in rpm, voltage, rated current in amperes per terminal, overload, time rating for overload, temperature rise for overload, number of phases, frequency, rated exciter voltage and rated field current.

8.41 Generator Specification

The generator shall be (belted) (direct coupled) to a (gas) (oil) (steam) engine. Generator shall be rated ... kva, ... % power factor, ... volts, ... phase, ... cycles, ... rpm. Temperature rise shall not exceed ... °C by (thermometer) (detector) on stator and ... °C by (thermometer) (resistance) on field. Generator unit shall be complete with (direct) (belt) connected exciter of suitable rating.

Generator manufacturer shall guarantee the following operating factors: Maximum temperature rise; stator ... °C, field ... °C. Maximum excitation required; ... kw at ... volts. Efficiencies at rated power factor; ... % at full load, ... % at ¾ load, ... % at ½ load.

8.5 Motor-Generator Sets

With increased application of high frequency for lighting and special purposes and of special electrical circuits for laboratories, etc., motor-generator clauses are becoming part of electrical specifications. Such clauses should include the following data.

Motor type, voltage, phase, horsepower, speed and frequency. Generator type, kva, power factor, speed, voltage, phase, frequency and related information about its exciter.

8.51 Emergency Generator Set

Give detailed information on engine drive (gasoline, gas, diesel, etc.), hp size etc.; also size and electrical characteristics of generator; also details of associated control. See Section 2.0 Service Entrances, 2.131 Standby Generator, for prototype specification.

8.52 Rotary Frequency Converter

The electrical contractor shall furnish and install (number) ... kw, motor-generator frequency converter(s) which will provide ... cycle, ... volt power for the high-frequency lighting system. The ... cycle generator phases shall be center tapped to ground so that the voltage will not exceed ... volts to ground. Each unit shall be a self-contained m-g set with associated control equipment contained in an all-metal drip-proof cabinet.

Each unit shall include the following components:

One induction drive motor ... hp, Type ..., ... rpm, ... volts, ... phase, 60 cycle integrally connected to:

One synchronous generator ... kva, Type ..., ... power factor, ... rpm, ... volts, ... phase, ... cycle, with overhung exciter.

One input fused disconnect switch, ... amp, ... volt, ... pole, ... phase, 60 cycle.

One full-voltage motor starter with overload and under-voltage protection rated for the motor.

One voltage regulator.

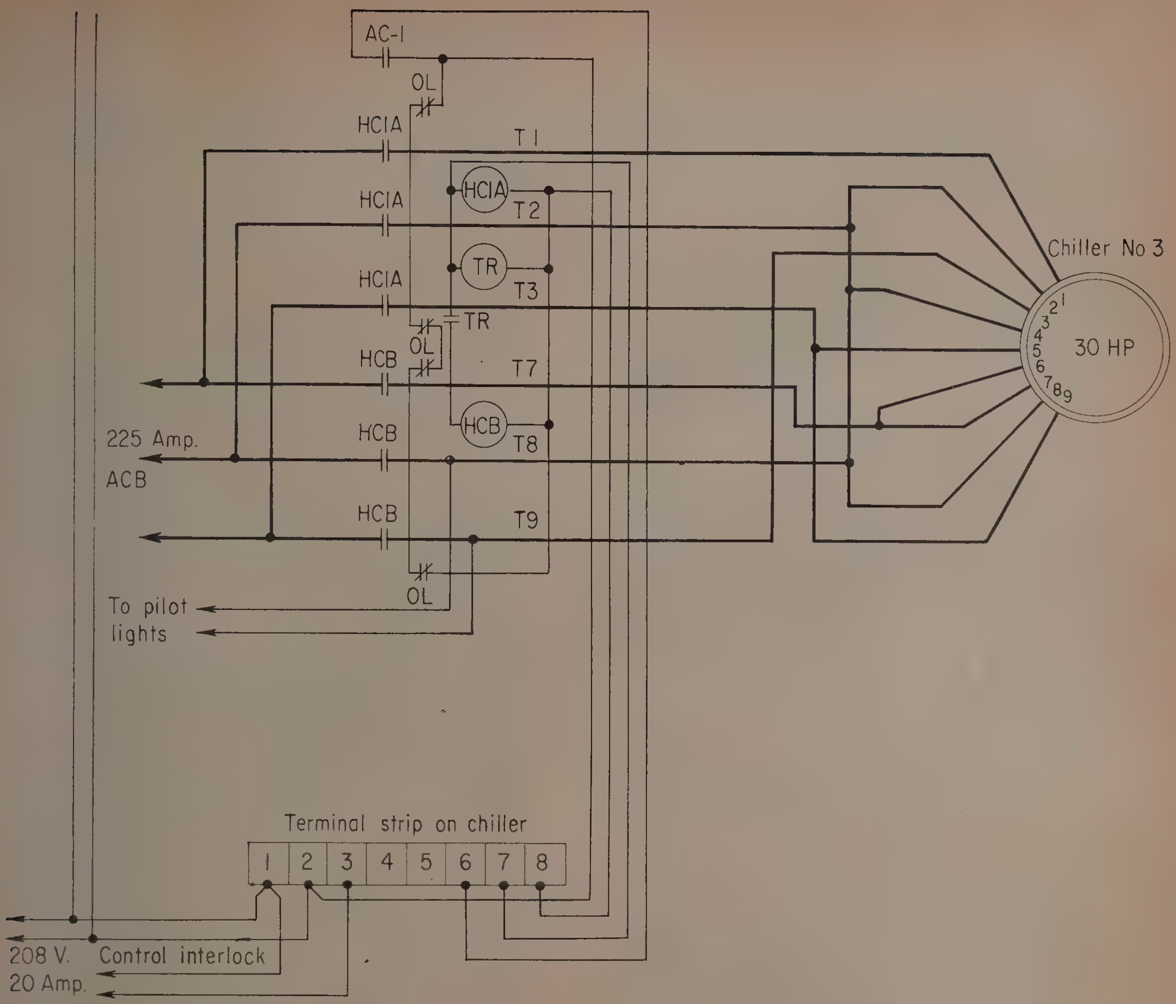
Suitable output control consisting of (number), Type ..., ... pole (circuit breakers) (switches) rated .. amp, ... volt, for use on ... cycle circuits.

The rotary frequency-converter unit(s) shall be as manufactured by ...... Company, or approved equal.

8.6 Motor Controls

Where several motors of like capacities, design, characteristics and application are to be installed, detailed control specifications could be included with the motor specification clauses. When numerous motors of widely differing capacities, characteristics and functions are to be installed, a general specification could be written to cover motor-control equipment with additional clauses relating to those installations which do not follow the pattern.

Such general specifications could follow the outline



PART-WINDING STARTER is used to reduce inrush current to a 30-hp, 208-volt compressor motor with two separate delta windings. Motor starts with one parallel winding energized, operates with the two in parallel. Diagram details connections. Drawings like this facilitate estimating, field installation, and assure proper operation.

presented below. This includes only the more common types of general-purpose motor-control devices for ac motors. It is well to consult the manufacturers before specifying control equipment for special applications.

8.61 General Specification

Unless otherwise noted, motor starters shall be line-voltage (manual) (automatic) type with suitable thermal overload relays and reset and start-stop pushbuttons in the cover. Units shall be (Company), (Bulletin or Catalog designation), or approved equal.

Starters for . . . volt, . . . phase motors shall be line-voltage, magnetic type with 120-volt control. Provide 120-volt control-circuit transformers for all motors on the . . . volt system.

All motor controls, unless otherwise noted, shall be combination type with (circuit breaker) (fused or unfused switch) disconnect and magnetic motor starter in NEMA Type . . . enclosure. Combination starters shall be (Company) (Bulletin or Catalog designation), or approved equal.

Except where remote control is indicated, pushbuttons shall be in motor starter cover. Pushbuttons shall be . . . type, suitable for service intended and shall be as made by . . . . . . Company, or approved equal.

Where required, additional general clauses relating to reduced-voltage, multi-speed, reversing and similar specific control items may be added here. However, unless there is a reasonable number of each type involved, such items are covered by individual specifications.

8.62 Specific Controls

When specification of individual units is necessary to match selected equipment to the control problem at hand, pertinent starter and motor data should be considered and included in the specification clauses. Addition of information assures installation of proper items, facilitates pricing, ordering and delivery.

Whenever possible, one or more manufacturers' name and control designation should be indicated to establish type and quality desired.

Direct Current

Type: across-the-line, start-stop (and reverse), standard or heavy duty automatic reduced voltage.

Horsepower rating and type of motor controlled. Line voltage and motor amps.

Type of enclosure: NEMA Type I, Standard; Type II, Drip-tight; Type III, Weather-resistant; Type IV, Water-tight; etc.

Overload protection, reset button.

Pilot devices: pushbutton station; float switch; thermostat; etc.

Automatic operation; accelerate shunt, series and compound motors; accelerate shunt and compound motors; not suitable for jogging; etc.

Time limit of automatic operation: designed for one 10-second start out of each 80 seconds.

For constant-speed or adjustable-speed motor, number of accelerating points.

Non-reversing, with or without braking; reversing with braking.

Field accelerating and decelerating relays.

Low-voltage protection.

Field rheostat: manual, enclosed, for prescribed speed range of particular size motor.

Other relays: control, field protective, field failure.

Alternating Current

Type: across-the-line, manual starting switch; across-the-line, magnetic switch; reduced-voltage starter.

Horsepower rating and type of motor controlled.

Line voltage, frequency, full-load motor current and number of phases.

Type of enclosure: NEMA Type I, Standard; Type II, Drip-tight; etc.

Overload protection.

Pilot devices: pushbutton station; control switch; relay; thermostat; etc.

Number of poles.

Reversing.

Combining disconnect switch (or circuit breaker) in the same enclosure, with or without fuse clips for specific rating.

No voltage protection.

Maximum primary running current, for primary control of slip-ring motor.

For constant-speed or adjustable-speed operation.

Relays: automatic reset; low speed start; accelerating; decelerating; etc.

For multi-speed operation: consequent pole or separate winding; constant torque, variable torque or constant horsepower.

Reduced-voltage starters: manual (resistance, or autotransformer) type; magnetic (resistance, three-point resistance, stepless resistance, or transformer) type.

For reduced-voltage operation: particular conditons of the starter application—characteristics of driven machine, hookup of pilot devices, frequency of starting.

Synchronous motor starters: semi-magnetic, reduced voltage, autotransformer type; reduced voltage, autotransformer type; reduced voltage, resistance type; magnetic, full-voltage, across-the-line type.

For synchronous motor starters: kva, rpm, power factor, full load amperes, phases and frequency, voltage, field voltage, excitation amperes, size and rating of field discharge resistor.

Squirrel-cage motor starters for high voltage: across-the-line type; reduced-voltage, autotransformer type.

For high-voltage squirrel-cage motor starters: locked rotor current of motor.

Reversing drum switches for starting and reversing squirrel-cage motors, for ac or dc, with spring or non-spring return, for surface, panel or switchboard mounting.

Multi-speed drum switches for manually starting, speed changing and reversing 3- and 2-phase multi-speed motors (reversing or non-reversing).

Non-reversing drum switches for polyphase wound-rotor induction motors, for starting and speed regulating —with grid resistors and characteristics matched to motor operating conditions.

Control Accessories

Consider all of the following:

Manual speed regulators.

Pushbutton: standard duty, heavy duty, oiltight stations, etc.

Limit switches: ac, dc, precision.

Plugging switches.

Overload relays: thermal, magnetic.

Switches: pressure, temperature, float, limit, time, etc.

Timing relays: pneumatic, fluid dashpot, motor-driven, electronic, etc.

8.63 Control Specification

Depending upon equipment selection and system design, a motor-control specification might consist of one or more of the following typical clauses.

Controls for (fan, pump, etc.) motor shall provide for (full, reduced voltage) starting of the . . . hp, . . . rpm, . . . % pf, . . . volts, . . . phase, . . . cycle motors. Controls shall be in NEMA I enclosures, and designed for (full magnetic, semi-magnetic) operation. Reduced voltage at starting shall be obtained by means of (autotransformer, reactor, resistor) and shall limit the kva inrush to a maximum of . . . % of full load kva.

The control shall provide overload, undervoltage, damper winding and pullout protection and, after pull out of step, shall automatically stop (or re-synchronize) the motor. Control shall be as manufactured by . . . . . ., Type . . ., or approved equal.

Controls for squirrel-cage motors shall be combination 3-pole across-the-line starters with circuit breakers in NEMA Type . . . enclosures with self-indicating handles and shall provide overload, low-voltage and short-circuit protection. Breakers shall trip at . . . amps. Remote 2-unit standard-duty pushbutton stations, momentary contact, marked Start-Stop, shall be provided in NEMA Type . . . enclosures. Starters shall be as manufactured by . . . . . ., Class . . ., Type . . ., or approved equal.

Motor starters identified by symbol on the plans or in the control schedule shall be as follows:

Type A starters shall be manually operable for full-voltage starting by means of a lever, knob or pushbutton.

Type B starters shall be magnetically operable for full-voltage starting; shall have undervoltage protection and provision for connection of remote control stations.

Type C starters, for reduced-voltage starting, shall be of the manually operable autotransformer type. Each starter shall have undervoltage protection and a stop pushbutton in the cover.

Type D starters, for reduced-voltage starting, shall be of the magnetically operable autotransformer type. Each starter shall have undervoltage protection and provision for remote control.

Type E starters are for wound-rotor motor starting duty only. Each controller shall have a magnetically operated primary switch and a resistor switch with suitable resistors. The primary switch shall provide running overcurrent and undervoltage protection for the motor. An electrical interlock between primary and resistor switches shall prevent closing primary switch unless all resistors are connected. Resistor switches shall be dial type for motors of 10 hp or less; drum type for larger motors.

Type F controllers are for wound-rotor motor speed regulation duty. They shall provide for 50% speed reduction and continuous operation at any speed from maximum to minimum. In all other respects Type F controllers shall conform to Type E starter specifications.

9.0 Electric Space Heating

Electric space-heating systems are designed on the basis of precise heat-loss calculations of the area to be heated. Quantity and type of thermal insulation in the ceilings, walls and floors of the area involved have a definite bearing on the electrical capacity of the selected equipment and the operating cost of the installed system.

It is important to all concerned that system installation meet design requirements. Electric heat specifications should include pertinent information regarding insulation on which the design is based as well as electrical characteristics of and installation instructions for the selected equipment items. Equally important is a concise description or designation of selected control units for the equipment listed.

Electric resistance heating methods can be classified into four basic categories. They are:

1. Radiant—where radiant energy of various wave lengths is transmitted directly from a heated surface to instantly warm a person or object within a direct line range.
2. Convection—where a natural upward flow of heated air results from contact with a surface (a convector) heated by electric current.
3. Radiant and Convection—a combination of direct radiant energy from an electric heating unit and a natural upward flow of convected air resulting from difference in density.
4. Forced Air Flow—units where a fan forces air over an electric heating element and directs it through a housing or duct into the area to be heated.

Various electric heating units are currently available to provide any of the above types of space heating. Choice of system and specific equipment is the responsibility of the system design engineer. Factors influencing his selection may include: size and type of area to be heated; amount and type of thermal insulation in surrounding walls, ceilings and floors; amount and type of exterior glass and non-insulated wall areas contributing to heat loss; maintenance and economic considerations.

Components of the selected system should be specified in clear, concise terms. Emphasis should be placed on type and size of unit, exact location and specific control equipment.

Equipment Schedule

Where a number of different types of units are involved in a project, the addition of an Electric Heating Equipment Schedule (similar to the conventional lighting fixture schedule) is recommended. This can be noted on the plans or in the written specifications.

Typical column headings could read (from left to right): Plan Symbol; Location; Quantity; Type and Description; Unit Length; Unit Watts; Volts; Btu Output; Control; Remarks.

Typical schedules could be developed for a complete project, or for specific floors or areas in larger and more complex projects. Such a listing of heating equipment facilitates estimating, procurement and installation.

CHECK LIST

☐ **Circuit Characteristics**
  — watts, volts, amps, phase

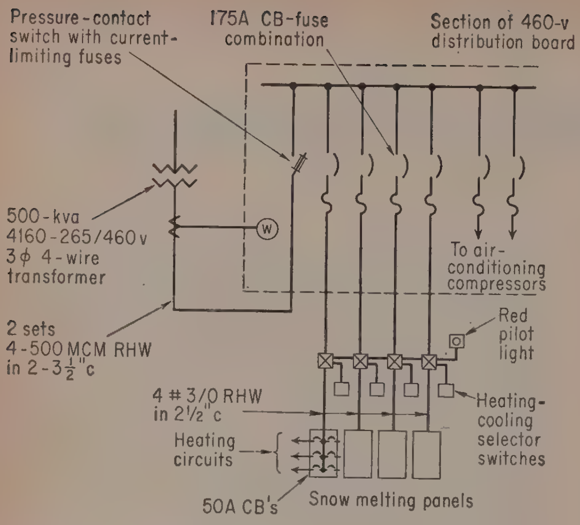
☐ **Equipment**
  To be furnished
    — by others
    — by electrical contractor
  Electrical characteristics
    — wattage of units
    — voltage, phase, frequency
    — heat output, Btu/hr
  Type of unit
    — baseboard, radiant and convection
    — wall panel, radiant, metal, glass
    — wall panel, forced convection (with fan)
    — heating cable, radiant
    — unit heater, fan circulation
    — ceiling panel
    — central furnace
    — heat pump
    — auxiliary units for air ducts
    — radiant heating fixtures
    — snow melting cable assemblies

☐ **Controls**
  To be furnished
    — by others
    — by electrical contractor
  Electrical characteristics
    — voltage, phase, frequency
    — wattage, amperes
    — operating temperature range; differential
  Type
    — manual, automatic
    — single stage, two-stage
    — line, low voltage with transformer and relays
    — built-in equipment mounted
    — wall mounted, surface, recessed
    — load regulators

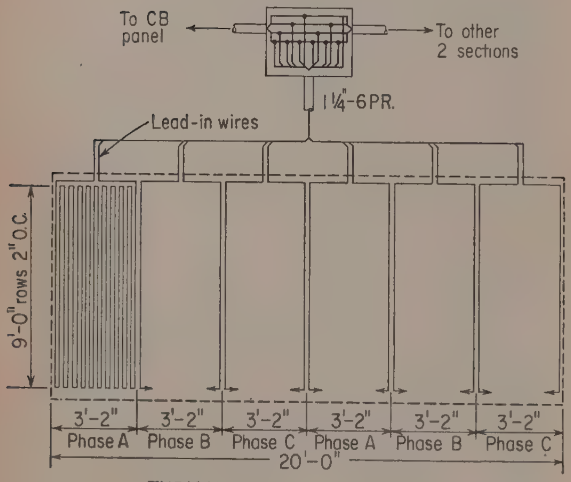
☐ **Installation**
  — mounting dimensions
  — special circuiting or control
  — detail drawings
  — equipment schedule

☐ **Insulation**
  — "R" numbers of insulation on which system design is based

☐ **Other items** pertinent to system design


Pressure-contact switch with current-limiting fuses
175A CB-fuse combination
Section of 460-v distribution board
500-kva 4160-265/460 v 3φ 4-wire transformer
W
To air-conditioning compressors
2 sets 4-500 MCM RHW in 2-3½"c
Red pilot light
4 # 3/0 RHW in 2½" c
Heating-cooling selector switches
Heating circuits
50A CB's
Snow melting panels

SINGLE-LINE WIRING DIAGRAM



TYPICAL SECTION OF SIDEWALK

DISTRIBUTION and circuit diagrams of electric snow-melting system for a department store sidewalk supplement specification paragraphs; facilitate proper installation.

9.1 Thermal Insulation

Knowing the close design relationship between building insulation and electric heating, electrical contractors are understandably interested in checking and determining if the proper type and quality of insulation is being installed. Generally, they are the first to receive possible complaints about the electric heating they installed.

While insulation details quite properly belong in the building or insulation specifications, it is good practice to include a short reference to same in the electrical specifications. The "R" numbers recently developed by the National Mineral Wool Association provide a simple reference designation. These numbers appear on various insulating materials and indicate an accurate measure of the installed insulating value of that material.

The "R" number designations replace the former 6-4-2 formula (inches of insulation) for ceilings, walls and floors. For example: To meet the All Weather Comfort Standard, insulation for an electrically heated home is now specified as—R-19 for ceilings; R-11 for walls; R-13 for floors.

A typical electric heating specification reference to building insulation might read as follows:

The electric heating system design for the (home, office, etc.) is based on the following installed insulation values: Ceilings, (R-); walls, (R-); floors, (R-). A vapor barrier, rated at one perm or less, if not built into the insulating materials, shall be installed.

9.2 Type of Unit

Specifications for electric heating equipment should include the following pertinent information:

Baseboard perimeter heating—a convection-radiation type of unit; specify length, wattage, voltage, Btu/hr, single- or two-heat type. Indicate if baseboard is to have built-in thermostats and/or receptacles.

Floor unit—flush mounted in floors, normally under floor-to-ceiling windows to provide an effective warm-air "wall." Units are convection type. Specify Btu/hr, wattage, voltage.

Wall panel—radiant type; or convection type, natural or forced (with fan). Specify wattage, voltage, Btu/hr.

Glass and other types of radiant heat panels for wall or ceiling installation. Specify size, Btu/hr, wattage, voltage, spacing.

Heating fixtures—radiant heat energy sources in a fixture or housing with built-in reflectors. For: comfort heating of people in exposed locations; controlled area heating in large uninsulated enclosures and open areas; and spot-heating applications. Specify size, type of heating element, Btu/hr, wattage, voltage, mounting.

Combination fixtures—to provide heating and lighting. Specify size, type of heating element and light source, Btu/hr, wattage, voltage, light output, type of mounting.

Heat pump—for use with a forced-air duct system. Specify whether one or two-stage type; Btu heating capacity (with and without auxiliary heating units); wattage and voltage of auxiliary heating units; number, hp, volts, phase, amperes of compressor and fan motors; total kilowatt input; coefficient of performance.

Duct heaters—resistance heaters installed in air ducts for primary or auxiliary heating. Specify Btu/hr, voltage, phase, wattage, physical dimensions.

Heating cable—for ceiling (or concrete floor) installation to provide radiant-type heating. Specify Btu/hr, maximum length in feet; color coding; wattage and voltage. Manufacturer's instructions should be followed.

Snow melting units—pre-assembled, pre-spaced heating cable fastened to steel-mesh mats ready-to-install. To melt snow and prevent ice formation on concrete drives, walkways, steps and similar areas. Specify size of mat (length and width), wattage and voltage; or length of wire, gauge, wattage and voltage of cable in custom engineered systems.

Any or all of the above types of electric space-heating units can be easily identified by manufacturer's name and model or catalog number, or approved equal, to incorporate the various specification points noted above.

9.3 Heating Controls

Electric heating permits the maximum in convenience, flexibility and comfort. To achieve this, automatic control equipment (thermostats, etc.) should be selected carefully and specified to match design requirements.

Among the more common methods of controlling electric heating equipment are the following:

Individual Unit—the thermostat control is built-in the wall or baseboard unit.

Room Control—a wall thermostat controls all heating units in the room.

Zone Control—heated area is divided into zones with each wall thermostat controlling all heating units in a specified zone or section.

Currently available control equipment is produced in a variety of models with operating and electrical features to meet specific requirements. When selecting and specifying electric heating control, consider these characteristics:

Single-stage or dual-stage operation.

Thermostat operation, frequent or slow cycling to maintain desired room temperature.

Single-pole or double-pole with marked position for breaking one side or both sides of the line.

Surface or recessed mounting, type of finish.

Line-voltage or low-voltage with associated relays and transformer.

Operating temperature range in degrees F, temperature differential.

Electrical rating in amperes, watts and volts.

The preferred method of specifying heating control equipment is by manufacturer's name, model and/or catalog number to identify a specific item containing the desired features. Descriptive clauses may be added if considered pertinent.

For more complex installations (schools, commercial buildings, etc.) where "day-night," "summer-winter," "holiday" and similar control features are desired, relevant electrical specifications might contain paragraphs explaining the desired operation of the specified control system.

Where supplemental unit or circuit control is desired, clearly note same in the specifications. Application of a load-control unit in areas with peak-load problems or restrictions is an example. These time-switch operated units automatically transfer the electric heating load from 240 volts to 120 volts, and back, during pre-set hours. Reduction of voltage reduces wattage of controlled heating units by about 75% during peak periods.

9.31 Control Specification

A typical specification relating to conventional thermostatic control might read as follows:

The electric heating system shall be (room) (zone) controlled by thermostats furnished by the electrical contractor and installed . . . ft above floor level at locations shown on the plans. Each thermostat shall control the number of heating units indicated.

Thermostats shall be . . . . . . Company, Model No. . . ., Catalog No. . . ., or approved equal. Units shall be line-voltage (low-voltage), single-pole (double-pole), single-stage (2-stage), type rated . . . watts, . . . volts. Operating temperature range shall be . . . °F to . . . °F, with a rated differential of . . . °F. Units shall be for surface (recessed) mounting as indicated and covers shall have a . . . finish.

Where a convenient remote control center is to be installed for pre-setting day and night temperatures for completely automatic or manual remote control of one or more zone thermostats, develop specification clauses covering type, size, operational and electrical features of the unit. Use manufacturer's technical literature as basis and specify model or catalog number, if possible.

Follow the same procedure for other types of control equipment, using the above prototype specification as a general guide. Be specific in all cases so intended equipment will be procured and installed.

Insulation Standards

New "R" values developed by the National Mineral Wool Association to define and designate insulation materials in terms of an installed performance standard.

Comfort level	Building Section	U-value Btuh/sq ft per deg TD	Installed Resistance and Product Designation [1]
Quality home requirements [2]	Ceiling	0.05	R-19
		0.04 [3]	R-24
	Wall	0.07	R-11
	Floor (over unheated space)	0.07	R-13
Moderate comfort and economy	Ceiling	0.07	R-13
	Wall	0.09	R-8
	Floor (over unheated space)	0.09	R-9
Minimum home requirements	Ceiling	0.10	R-9
	Wall	0.11	R-7
	Floor (over unheated space)	0.11	R-7

[1] Installed resistance (R) is the sum of the resistance of the mass insulation and the resistance of any adjacent air spaces or the resistance of any exposed insulation surface which may exist.

[2] Recommended by All-Weather Comfort Standard.

[3] For special situations where additional insulation is deemed necessary in ceiling.

Electric Heating Equipment Schedule

Plan Symbol	Location	Quantity	Type and Description	Unit Length	Unit Watts	Volts	Btu Output	Control	Remarks
A	Office	10	(Name, Cat. No.___, baseboard	8-ft	1250	240	4265	Thermostat	
B	Private Office	4	(Name, Cat. No.___, wall panels		1500	240	5118	Thermostat	
C	Washrooms	2	(Name, Cat. No. ___, wall units with fan		2000	240	6824	Thermostat and switch	

9.4 Heating Specifications

Space limitations preclude listing typical specification clauses for all types of electric heating equipment. With slight modification, the following prototype specification (for baseboard equipment) can be adapted to other types of units. Select and alter relevant paragraphs to fit the project design and selected equipment.

Data to Aid Selection and Specification of Fixture-Type Heating Units

Basic Heat Densities (0° F outside design temp.)*

Type of area to be heated	Watts per sq ft
Insulated building	10
Uninsulated building	16
Shell-type (Quonset)	19
Glass porch	22
Outdoors, partly sheltered	24
Outdoors, no shelter	27

* For 9-ft mounting height
Add 10% for each foot above 9 ft.
Subtract 10% for each foot below 9 ft.

Correction for Outside Design Temperature*

Outside design temperature (°F)	Watts/sq ft to be added	Outside design temperature (°F)	Watts/sq ft to be subtracted
−30	4½	+30	4½
−25	3¾	+25	3¾
−20	3	+20	3
−15	2¼	+15	2¼
−10	1½	+10	1½
− 5	¾	+ 5	¾
0	0	0	0

* Add to or subtract from Basic Heat Densities

Heater Coverage*

Height of fixture from floor (ft)‡	Heaters rated 1000, 1500, or 2000 watts		Heaters rated 3000 or 4000 watts	
	Floor area dimensions (ft)†	Floor area (sq ft)	Floor area dimensions (ft)†	Floor area (sq ft)
9	10 x 13	130	10 x 15	150
10	11 x 14	154	11 x 16	176
12	13 x 16	208	13 x 18	234
13	14 x 17	238	14 x 19	266
15	16 x 19	304	16 x 21	336
17	18 x 21	378	18 x 23	414

* Heater suspended horizontally. Coverage varies with heater length and reflector type. Check manufacturer's data.

† Second figure is dimension parallel to length of fixture

‡ Where angle radiation is employed, use the distance measured along the axis of radiation rather than the mounting height.

Heating Units

The electrical contractor shall furnish and install electric space-heating units as noted on the plans and listed in the Electric Heating Equipment Schedule. Installation shall be in strict conformance to NEC and applicable local regulations for this type of equipment.

Separate circuits of sizes and type indicated shall be installed as shown on the plans. Connections from branch-circuit outlets to heater unit raceway or junction box shall be made with (specify type of raceway connection).

Heating units shall be . . . . . . Company, (trade name), or approved equal, baseboard type of single-heat (two-heat) construction as noted on the Schedule, for operation on a . . . volt, . . . phase, . . . wire distribution system. Specified catalog numbers indicate heater length, Btu/hr output, wattage and voltage of individual units.

Equipment shall be supplied complete with required blank sections, corner and trim accessories to provide an uninterrupted perimeter installation as shown on the plans. Units shall be (surface) (semi-recessed) mounted.

Controls

a. Heating equipment shall be automatically controlled by thermostats built-in the individual units (or baseboard). (Specify thermostat characteristics.)

b. Heating units shall be automatically controlled by wall thermostats installed where indicated on the plans. (Refer to Section 9.31 for thermostat specification.)

c. Control equipment for the electric heating system shall consist of: (add specification paragraphs listing or describing other types of control equipment items).

Accessories

Receptacles in the . . . area indicated on the plans shall be built in the electric baseboard heating enclosure. Outlet sections shall be designed for use with the heating unit specified. Receptacles shall be served by separate circuits, not connected to heating circuits.

Heating Fixtures

Specify size and type of fixture and reflector; type of heating element; watts, volts, heat output; spacing and mounting height.

Heating Cable

Specify standard length of heating cable to be installed in the area, noting prescribed wattage of cable length and system voltage. Cable cannot be cut to fit on job. Include instructions to check electrical continuity of cable before and after installation; also precaution to follow manufacturer's installation recommendations.

Snow-Melting Mats

Specify number and size of snow-melting assemblies to be installed in indicated areas. A typical specification might read:

Furnish and install, where indicated on the plans, (number) pre-assembled electric snow-melting mats. The mats shall be . . . ft by . . . ft (in.) and rated . . . watts at . . . volts. Heating cable shall be rated . . . watts per lineal foot; shall have a (nylon) (neoprene) (. . .) covering and shall be pre-spaced and mechanically attached to a galvanized steel mesh. Permanent connections between heating cable and "cold" leads shall be pre-sealed at the factory.

Mats shall carry UL listing for application intended and shall be as manufactured by . . . . . . Company, or approved equal.

Watertight junction boxes housing power lead connections shall be sealed with melted (paraffin) (. . .) to seal splices against moisture ingress.

9.5 Installation Instructions

It is good practice to include any special instructions and details regarding equipment to be installed in the relevant sections of the specification.

10.0 Residential Wiring

CHECK LIST

- ☐ **Codes** — NEC, local, etc.
- ☐ **Contracts** — with owner, developer, builder
- ☐ **Permits, Fees** — secured and paid by whom
- ☐ **Temporary Power** — who shall furnish and use facilities; who pays for energy consumed
- ☐ **Service Entrance** — volts, amps, phase, wire
  - Underground (direct burial, in duct)
    - conductors — size, insulation type, single conductor or cable assembly — ducts — metal, fiber, Transite, etc.
  - Overhead (single conductors, cable assembly)
    - conductor size, type insulation, type of cable (SE), (ASE), etc.
  - Location — check local utility rules
- ☐ **Service Switch and Panel** — size of mains, volts, amps, phase
  - number and size of branches
  - switches and fuses
  - circuit breakers
- ☐ **Load Centers** — same information as for panels above
- ☐ **Branch Circuit Wiring** (check local codes)
  - knob and tube
  - non-metallic sheath cable
  - armored cable
  - flexible conduit and wire
  - EMT and wire
  - rigid conduit and wire
- ☐ **Branch Circuits** — number and type
  - lighting
  - general purpose
  - fixed appliance
  - multi-wire appliance
  - full circuit appliance
  - special purpose (outdoor lighting, receptacles, etc.)
- ☐ **Wiring Devices**— rating and type and color of each
  - standard
  - interchangeable
  - Switches — number of poles, 3-way, 4-way, 2-circuit, standard, silent operation
    - push type, tumbler, rotary, illuminated
    - master, time, door, special purpose
    - dimmer control for lighting
  - Receptacles — rating, type and color of each
    - single, duplex, triplex
    - split circuit, switched
    - standard grounding type
    - combination 125-, 250-volt grounding type
    - special purpose appliance type
  - Plates — metal or composition, switch or receptacle, color and finish, weatherproof
- ☐ **Low Voltage Remote Control System** — number of switches, relays, master stations, number of devices controlled
- ☐ **Air Conditioning**—type (central, room units), capacity, electrical rating (amps, volts, phase)
- ☐ **Electric Heating**
  - Space — type of units, rating (amps, volts), number of control thermostats
  - Snow removal — pre-assembled heating cable on steel mesh mats. Type, size (. . . ft x . . . in.), rating (watts, volts), control switch
- ☐ **Exhaust Fans** — type, capacity, electrical rating for kitchen, bath, attic, etc.
- ☐ **Signal and Communications**
  - telephone
  - intercom system
  - fire alarm system
  - TV antenna system
  - high fidelity sound system
- ☐ **Lighting Fixtures** — type and wattage of each
  - to be furnished by. . . . . .
  - to be installed by. . . . . .
  - types as indicated on fixture schedule
- ☐ **Other items** as required by specific project

The modern concept of total electrical living, full housepower and "Medallion" homes is a vital consideration in the design and specification of residential wiring systems.

Current availability of a wide range of high-wattage appliances and equipment (ranges, water heaters, dish washers, laundry equipment, electric space heating, etc.) makes electric service capacity a prime factor in the design of new and rewired residential systems. Capacity must be adequate for apparent loads and include a reasonable allowance for future additions. The NEC recommends a 100-amp service for single-family residences; makes it a mandatory minimum if the net computed load is 10 kw or more. Some local regulations require a 200-amp service. Check all relevant regulations to assure compliance.

Service-entrance capacity can be computed by methods outlined in Articles 220, 230 and Chapter 9 of the NEC. The results obtained will be based on safety and may not be entirely adequate from a desired performance standpoint. Check on the convenience desires and living habits (electrical use routine) of the homeowner.

The same approach applies to design and specification of branch-circuit capacity and convenience. The minimum NEC safety requirements should be supplemented to an extent that will provide the homeowner with the electrical system adequacy, utility, efficiency and convenience he expects and wants. Subsequent discussions and recommended prototype specification clauses are based on this premise.

10.1 Service

Furnish and install the following service entrance where shown on the plans (check with local utility regulations regarding exact location).

Service-entrance conductors shall be . . . No. . . . with Type . . . insulation (R, RW, T, RH, etc.) with a total capacity of . . . amps.

Service-entrance conductors shall be:

(a) Service-entrance cable (SE)

(b) Armored service-entrance cable (ASE)

(c) Installed in . . . in. conduit

(d) Underground service-entrance cable (USE) in accordance with the rules and requirements of applicable codes and the rules of the utility company serving the property.

10.11 Underground

From a point on the utility pole 4 in. above the upper conductor of the distribution lines adding 30 in. for drip loops and connections, provide a USE cable of the size specified to the service terminals of the service switch (meter box, service panel, etc.). Check local utility regulations.

From a point on the pole 8 ft above grade provide a run of . . . in. rigid conduit down below grade with an elbow terminating at the level of the underground run. Provide insulating bushings at each end of the protective conduit run. The conduit shall be firmly attached to the pole with at least two approved supports.

Cable for the run up the pole shall be neatly coiled above the protective conduit for utility connection. The utility will install the coiled cable on the pole with protective wood molding, seal the upper entrance to the conduit, and make final connections.

a. Cable shall be buried to a depth of 30 in. (or below frost line). Where cable passes under driveways it shall be covered by 6- by 2-in. creosoted wood planking to a distance of 3 ft beyond each side of the driveway.

At the building end of the underground run the cable shall be enclosed in a rigid conduit to a distance of 5 ft from the walls.

Where the cable enters the conduit, at each end of the underground run, the conduit shall be sealed with oakum and sealing compound. The seals shall be surrounded by 6 in. of sand in all directions before back filling.

b. Extend the service conductor in rigid conduit underground at a depth of . . . in.

c. Extend the service conductor in approved (fiber, Transite, etc.) conduit underground from the pole to the building.

10.2 Panel and Switches

Conventional residential service-entrance equipment combines main service disconnect, major appliance circuit disconnects and lighting branch-circuit facilities in a single flush- or surface-mounted enclosure. Available panel arrangements permit the "main" to control all circuits or just the lighting circuits with major appliance branches (range, water heater, etc.) paralleled to the "main" as permitted by the NEC "six-circuit" rule. Note desired arrangement in the specifications.

While most residential systems use a single panel, there are cases where additional economy and convenience can be provided by dividing the number of branch circuits among one or more additional panels installed near load concentrations. Feeders from the entrance panel serve these load centers.

An empty raceway access to spares should be provided for all panels and load centers installed flush in living areas. A 1-in. raceway terminating in a junction box in the basement or attic area will usually suffice.

If the branch-circuit protective devices are circuit breakers, the NEC now requires that they be of the non-interchangeable type.

10.21 Service Panel

Where indicated on the plans, furnish and install a UL listed service-entrance panel with . . . amp mains and the following circuits: (List type and size of circuits and describe connection of main disconnects, if more than one. Or use a catalog designation to identify desired equipment.)

Panel shall be dead-front type for (surface, flush) mounting with circuit overcurrent protection provided by:

a. fuses

b. circuit breakers (magnetic, thermal-magnetic, etc.)

Panel shall be . . . . . . Company, Type . . ., or approved equal.

From the entrance panel provide (number) feeder(s) of . . . No. . . . Type . . . conductors (specify cable or type of raceway to be used) to the mains of the load center(s) as indicated.

If a separate main-entrance switch is required, specify type, number of poles, ampere and voltage rating; also that unit must be approved for use as a service-entrance switch.

10.22 Load Centers

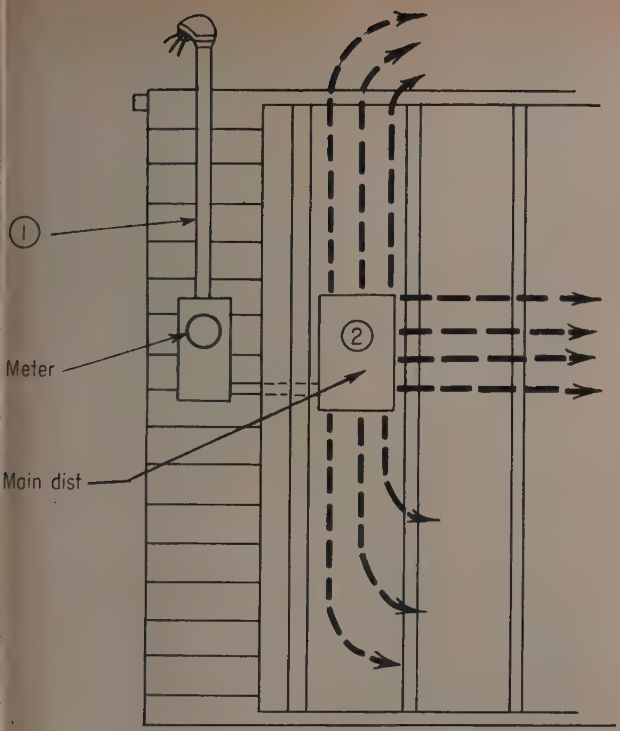
Where indicated on the plans, furnish and install (manufacturer's name), Type . . ., or approved equal, load centers for (surface, flush) mounting as indicated. Units shall be of size (number and ampere rating of branch circuits and mains) and type (fuse, circuit breaker) as noted.

10.3 Wiring Methods

The method of wiring single-family residences is usually determined by local ordinance or historical practice. While the NEC approves several methods (nonmetallic sheathed cable, armored cable, EMT, rigid conduit, etc.), local electrical ordinances may prohibit or restrict the use of some.

Indicate the type of wiring to be installed in general or in specific areas if more than one type is to be specified.

Wiring shall be . . . (specify wiring method) installed in compliance with NEC regulations and local rules and ordinances which apply. All accessories and devices shall be approved for use with the system indicated. Cutting and drilling of structural members shall be limited to that essential to proper installation. All cable, raceways and outlet boxes shall be securely anchored and the complete installation made in a mechanically and electrically sound manner.



TYPICAL FULLY EQUIPPED RESIDENCE

① Service capacity
140 to 200 amps

② Adequate distribution
30 circuits

4	General lighting circuits
2	Kitchen appliance circuits
1	Disposal circuit
1	Dishwasher circuit
1*	Range circuit
1	Deepfreeze circuit
1	Automatic washer circuit
1*	Automatic dryer circuit
1	Ironer circuit
1	Heating plant circuit
1**	Water heater circuit
2	Window A/C circuits
2	Home movie and photo equipment circuits
2	Home workshop equipment circuits
1	Outdoor equipment and decorative lighting circuit
1	Garage and yard lighting circuit
1	Bath fan and heater circuit
1	Cove lighting circuit
1	Sump pump circuit
1	Recreation area circuit
3	Spare circuits
30	

* 220 volt circuit

** Water heater requires additional meter and entrance switch in some areas.

SERVICE-ENTRANCE drawing for typical residence shows location of outdoor meter in relation to service-entrance panel. Listing of branch circuits tells electrical adequacy story. Sketch is important supplement to specifications and electrical layout sheets, to clearly convey the physical concept of construction to the installer.

Non-metallic sheathed cable assemblies serving grounding-type receptacles shall contain a grounding conductor firmly connected at the outlet to the box (if metal) and to the grounding terminal of the device.

10.31 Outlet Boxes

Outlet boxes shall be of standard (metal) (non-metallic) type as manufactured by ...... Company, or approved equal. Boxes shall be of proper type and size to accommodate the fixtures or devices indicated and to meet structural conditions encountered. Boxes shall be securely fastened in place with hangers, brackets, or other methods approved for the purpose.

Outlet boxes shall be (a) knockout type with separate cable clamps or connectors (locknuts and bushings, etc.); (b) equipped with integral cable clamps or connectors. Unused knockouts shall be left in place or provided with an approved closure.

Locknuts or connectors shall be set up tight to provide a firm mechanical and electrical connection.

10.32 Surface Wiring

Where non-metallic surface wiring devices are indicated for basement, garage or attic areas, devices shall be of approved type installed as recommended by the manufacturer. Non-metallic sheathed cable circuits shall be independently supported within ... in. of boxes.

Where armored cable circuits are to be run exposed in areas indicated, outlet boxes and wiring devices shall be suitable for exposed work. Cable installation shall follow NEC or local regulations.

Where (rigid conduit) (EMT) is to be surface mounted, outlets and devices shall be suitable for exposed work. Boxes shall be of metal type with rounded corners and fitted covers designed for the device installed. All unused openings (knockouts, etc.) in boxes shall be covered.

Where surface-type metal raceways are indicated, raceways shall be ...... Company, No. ..., or approved equal, installed square with elbows, boxes, connectors and closures designed specifically for use with the raceway indicated.

10.4 Branch Circuits

In addition to adequate service-entrance capacity, the number and type of branch circuits installed in a residence establish the utility of the electrical system and electrical convenience of the home. Beyond normal lighting and receptacle facilities, the following circuits permit safe and efficient use of appliances and should be considered when specifying a residential wiring system. Many of these are covered in subsequent typical specification clauses in bold-face type.

a. Multi-wire appliance circuits: Kitchen and dining areas need at least two 20-amp circuits to handle simultaneous operation of groups of high-wattage appliances. A 3-wire, common-neutral circuit with each plug receptacle on alternate sides of the circuit gives some assistance against overloading.

b. Full circuits to fixed appliances: Provide separate circuit to such units as a dishwasher, disposer, automatic washer, room air conditioner, ironer, bathroom or nursery heater, etc.

c. Full circuit to appliance groups: Provide a separate circuit to a group of units such as refrigerator, food freezer and heating plant. (Some local codes require an individual circuit to an automatic heating plant.)

d. Load-center panel: Economical circuiting for modern appliance loads may require load-center panels near appliance groupings.

e. Circuit protection: Use of time-delay fuses or circuit breakers on circuits serving motorized appliances to prevent momentary starting current interruption.

Adapt any or all of the following specification clauses in developing branch-circuit specifications for a specific residential layout.

10.41 Branch Circuits—General

Furnish and install branch circuits from the panelboard(s) to the outlets as shown on the plans or described in the outlet or branch-circuit schedule. Circuits shall be of the type and size as noted.

10.42 Lighting

General-purpose lighting and receptacle, circuits in areas other than kitchen, dining room, laundry-utility room, basement or porch shall be 2-wire No. 14 (No. 12). There shall be one 15-amp circuit for each 375 sq ft of floor area (20-amp for each 500 sq ft) as indicated on the plans.

10.43 Appliance

Plug receptacles in the kitchen, laundry-utility room, basement and porch, other than those on special circuits, shall be served by not less than two No. 12, 20-amp appliance circuits. A 3-wire circuit with individual receptacles connected alternately to either side is permitted.

10.44 Isolating

Plug receptacles for the refrigerator and freezer and the outlet for connecting the heating plant shall be served by separate No. 12, 20-amp branch circuits. (In some communities codes may require an individual disconnect for the heating plant.)

10.45 Individual

Plug receptacles for connection of the following appliances shall be served by individual No. 12, 20-amp appliance circuits:

Automatic clothes washer
Electric dishwasher and disposer unit
Bathroom heater
Nursery heater
Room cooler
Attic fan
Hobby bench

The outlet for the electric clothes dryer shall be served by an individual 3-wire, No. 10 circuit terminating in an approved 30-amp, 3-wire flush (surface) receptacle.

The outlet for connecting the electric range shall be served by a 3-wire No. 6 circuit terminating in an approved flush (surface) 50-amp 3-wire receptacle.

The outlet for connecting the electric water heater shall be wired in accordance with the requirements of the local utility. (Local requirements vary depending upon metering provisions, permissible element capacities, etc. The utility rules should be consulted.)

Carefully check rating of range, water heater, clothes dryer, etc., to be installed. Be certain of wattage requirements before specifying circuit and receptacle size.

10.46 Unit Air Conditioners

A special-purpose outlet, located at the most likely point of installation, on a separate No. 12 circuit should be installed in each principal living area and in each bedroom for unit air conditioners.

The use of general-purpose or appliance circuits to serve air conditioners is not recommended.

If unit is of the reverse-cycle "junior heat pump" type with supplementary resistance heating unit, circuit will have to be sized accordingly.

10.5 Wiring Devices

Furnish and install, where shown on the plans or noted in the outlet schedule, the wiring devices indicated. Devices shall be of (best) (specification) grade and of color noted. Plates shall be (composition, metal), furnished in (note color or finish) and of single or gang type as required.

Wiring devices shall be as manufactured by ...... Company, or approved equal.

10.51 Outlet Location

The plans indicate approximate outlet location. Exact location of all outlets shall be as directed by (architect, owner, etc.). Unless otherwise noted, wiring devices outlets shall be installed as follows:

Convenience outlets; . . . in. above floor.
Appliance outlets; . . . in. above counters.
Switches; . . . in. above floor.
Telephone, TV, Hi-Fi; . . . in. above floor, or as directed.
Intercom; . . . in. above floor.
All other outlets; as noted.

10.52 Switches

a. Furnish and install at each switch outlet a quiet-operating, specification-grade switch, single-pole, 3-way or 4-way as indicated.

b. Furnish and install at each switch outlet a T-rated tumbler-type switch, single-pole, 3-way or 4-way as indicated.

c. Where indicated on the plans, furnish and install a 2-circuit switch to control the fixture(s) and/or circuit(s) noted. Switch is to provide (2) (3) levels of lighting intensity as indicated.

All switches shall contain (screw) (screwless) connections arranged for (side) (back) wiring.

Where 2-pole, push-type, rotary, illuminated-toggle, or other special switches and plates are to be installed, indicate same and note location in appropriate specification clauses.

10.53 Dimmer Switches

Furnish and install where shown on the plans, dimmer controls as manufactured by the ...... Company, No. . . ., or approved equal. Controls shall be of the autotransformer type and shall be installed and connected in an approved manner according to manufacturer's instructions. Capacity of each dimmer shall be . . . watts incandescent, . . . watts R/S fluorescent.

Where shown on the plans, furnish and install a 2-position, "high-low" dimmer switch or a (full) (half) range semi-conductor dimmer switch. Switch shall be ...... Company, or approved equal.

10.55 Receptacles

Furnish and install at receptacle outlets on lighting circuits a (duplex, triplex) plug receptacle, 15-amp, 120-volt for parallel-blade attachment caps.

Where noted on the plans, receptacles shall be switch-controlled as indicated.

Furnish and install at receptacle outlets on appliance circuits a grounding-type duplex plug receptacle, 15-amp, 120-volt designed to handle either parallel-blade or grounding-type attachment caps.

At locations shown on plans furnish and install:

a. (For 115-volt air conditioners) a 15-amp 125-volt grounding-type receptacle of the parallel-blade type.

b. (For 230-volt air conditioners) a 15-amp 250-volt grounding-type receptacle of the tandem-blade type.

Receptacles and plates located outdoors shall be weatherproof type with ... type closure.

All duplex receptacles shall contain (screw) (screwless) connections arranged for (side) (back) wiring.

10.56 Multi-Outlet Assemblies

Multiple outlets assemblies shall be furnished and installed where shown on the plans or indicated in the outlet schedule. Each section shown shall be continuous with outlets spaced ... in. apart.

On lighting circuits the assembly shall be designed to take standard parallel-blade attachment caps.

a. They shall be a 2-wire type with switch control as shown or described on the outlet schedule.

b. They shall be the divided-circuit type with upper positions switched as shown.

On appliance circuits, the assembly shall be grounding type designed to take either standard parallel-blade attachment caps or grounding-type attachment caps on any outlet.

Where multi-outlet assemblies are of the metal-raceway type, they shall be ...... Company, No. ..., or approved equal, and shall be installed as a complete system with elbows, couplings, closure strips, trim strips, and receptacles specifically designed for the raceway.

10.6 Relay Switching

Switch control of the outlets noted on the plans shall be provided by a low-voltage remote-control system as manufactured by the ...... Company, or approved equal. All wiring, relays, switches and components shall be designed for use with this system. (See 6.93 Low-Voltage Control in Section 6.0 Branch Circuits for detailed specifications.)

10.7 Exhaust Fans

Kitchen: Furnish and install where shown on plans a kitchen exhaust fan Catalog No. ... as made by ...... Company, or approved equal. Fan shall be designed to handle not less than ... cu ft of air per minute. External opening shall be provided with (specify type of louver, closure, or vent). Fan shall be controlled by (specify type and location of switch).

Attic: Furnish and install where shown on plans an attic exhaust fan Catalog No. ... as made by ...... Company, or approved equal. Fan shall be designed to handle not less than ... cu ft of air per minute. External opening shall be provided with (specify type of louver, closure, or vent). Fan shall be controlled by (specify type and location of switch).

Load and Circuit Values for Special-Purpose Circuits

Appliance	Typical Wattage	Circuit Conductors	Voltage	Circuit Protection
Range	10,800	No. 6	120/240	50-amp 2p
Oven (built-in)	4,500	No. 10	240	30-amp 2p
Range top (2-unit)	3,000	No. 12	120/240	20-amp 2p
Range top (4-unit)	6,000	No. 10	120/240	30-amp 2p
Dishwasher	1,200	No. 12	120	20-amp 1p
Refrigerator-freezer	600	No. 12	120	20-amp 1p (1)
Dryer	5,000	No. 10	120/240	30-amp 2p
Washer-dryer	5,000	No. 10	120/240	30-amp 2p
Washer	1,200	No. 12	120	20-amp 1p (2)
Ironer	1,600	No. 12	120	20-amp 1p
Water heater	3,000	No. 10	240	20-amp 2p (3)
Air cond. ¾ hp	1,000	No. 12	120	20-amp 1p
Air cond. 1½ hp	2,300	No. 12	240	20-amp 2p
Air cond. (central)				
5 hp	6,500	No. 6	120/240	70-amp 2p (4)
3 hp	4,000	No. 8	120/240	50-amp 2p
Heat pump				
5 hp	6,500	No. 6	120/240	70-amp 2p (4)
Supplementary	10,000	No. 6	240	50-amp 2p (5)
Heating plant	500	No. 12	120	20-amp 1p (6)
Attic fan ½ hp	800	No. 12	120	20-amp 1p
Water pump 1 hp	1,500	No. 12	240	20-amp 2p
Sump pump	500	No. 12	120	20-amp 1p
Bathroom heater	1,500	No. 12	120	20-amp 1p
Electric space heat	15,000	(as required)		(7)

Notes:

(1) It is recommended that refrigerators and freezers be on a separate circuit with no other outlets.

(2) Separate circuits are recommended for automatic washers and ironers.

(3) Water heaters involving off-peak rates require special circuits. Consult local utility for connections.

(4) Central air conditioning load and circuit requirements vary with the size and capacity of the unit. Install wiring according to manufacturer's instructions.

(5) Heat pump load and circuit requirements vary with the size and capacity of the unit. Install wiring according to manufacturer's instructions.

(6) Many local ordinances require a separate circuit for the oil burner or heating plant.

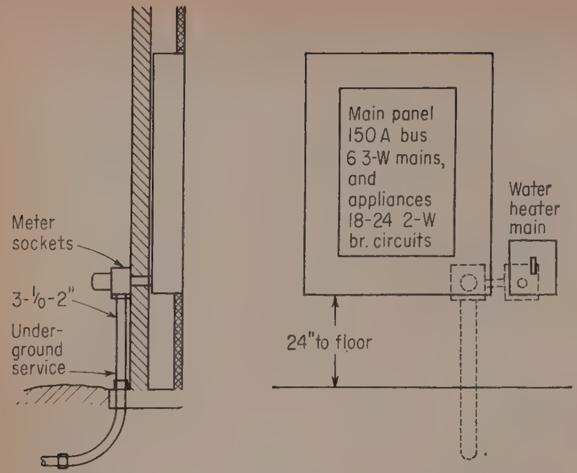
(7) Electric heating load and circuit requirements vary with the heating design. Fixed electric space heating units can be connected conveniently to No. 12 and No. 10, 240-volt branch circuits. Connected load should not exceed 80% of circuit capacity.

10.8 Space Heating

Specifications for electric space heating should describe the type, capacity and location of each unit or group of units and the type and location of each thermostat and associated relay designating the units controlled.

Indicate whether the thermostatic control is to be integral with the heating units or wall mounted (note location and mounting height). Specify control characteristics: watts; volts; line or low voltage; single- or dual-stage operation; temperature range and differential; number of heating units per thermostat; individual unit, room or zone control; and similar pertinent information. Use manufacturer's catalog numbers to indicate type, quality and characteristics of units. Plans should show circuiting to match control method specified.

Installation of heating equipment should follow rules noted in Sections 422-23 through 422-38 of the NEC and any local ordinances that may apply.


Meter sockets
3-½-2"
Under-ground service
Main panel 150A bus 6 3-W mains, and appliances 18-24 2-W br. circuits
Water heater main
24" to floor

SIMPLE SKETCH clarifies underground service specified for a home. Added dimensions prevent installation misunderstandings.

Building insulation is an important factor in determining installed capacity and operating efficiency of an electric space-heating system. Such systems are designed on the premise that the type and quality of insulation considered in the basic design calculations will be installed in the home.

While details of insulation quite properly belong in the building or insulation specifications, it is good practice to include a reference to same in the electric heating specifications. The close design relationship between the two makes it imperative that the electrical contractor know the type of insulation that has been specified and is being installed. Generally, he will be the first to receive possible complaints about the operation of the electric heating system he installed.

The "R" numbers, developed by the National Mineral Wool Association to indicate performance standards of various insulations, provide a simple method of specifying or referring to ceiling, wall and floor insulations used in the original electric heating design calculations.

Infrared heating "fixtures" are now available for comfort heating of open areas (open or covered patios, porches, etc.). Specify number, type, wattage, voltage, installation details, and desired control facilities for such applications.

See Section 9.0 Electric Heating for additional details and suggested specification clauses.

10.81 Snow-Melting Equipment

Pre-assembled, ready-to-install electric heating cable mats are now available for melting snow and preventing ice accumulation on driveways, sidewalks, steps, patios, etc. Mats are produced in a variety of lengths, widths and wattages for use on 208- to 230-volt circuits. Selected sizes and wattages can be specified by indicating manufacturers' catalog designation for units required. Specify type of disconnect to control circuits.

To assure proper installation and efficient operation, manufacturers' installation recommendations should be carefully followed.

See Section 9.0 Electric Heating for prototype specification clauses.

10.9 Signal and Communication Systems

10.91 Door Chimes and Signals

Furnish and install where indicated on the plans door chimes having . . . notes, as manufactured by . . . . . . Company, No. . . ., or approved equal. Chimes shall be for (recessed, surface) mounting and shall be complete with transformer, pushbuttons and components. Wire complete to button in door station plates at all locations designated on the plans.

10.92 Intercom Systems

Furnish and install a complete . . . station intercom system with master station located in the . . . room and other stations located as noted on the plans. System shall be the . . . Type, as manufactured by the . . . . . . Company, or approved equal. System shall be installed in accordance with manufacturer's instructions and left fully equipped and in first-class operating condition. (For more detailed specifications, see Section 11.0 Signal, Communications and Auxiliary Systems.)

10.93 Fire-Alarm Systems

Furnish and install a (trade name or catalog number) fire-alarm system manufactured by the . . . . . . Company, or approved equal. Sensing units and alarm shall be located and installed as indicated on the plans. All wiring shall be in accordance with manufacturer's recommendations and local regulations.

Detectors, (fixed-temperature) (combination fixed and rate-of-rise) types, shall be factory set and contain NO, SP contacts, which will close the warning circuit when the ambient temperature reaches . . . F in living areas and . . . F in the furnace area. System components shall be listed by UL. System shall be tested in presence of (authorized personnel).

10.94 Television-Antenna Systems

Furnish and install a (trade name or catalog number) concealed television-antenna wiring system for . . . outlets, as manufactured by the . . . . . . Company, or approved equal. System shall be complete with multiple-outlet coupler (for two or more outlets), TV plug-in wall outlets of proper type, and attic-mounted antenna (or combination roof mast holder and weatherproof lead-in entrance; or waterproof lead-in entrance).

Where outdoor roof antenna is indicated, the electrical contractor shall leave sufficient lead-in wire coiled on the roof for connection to the antenna. TV lead-in entrance shall be located at least 15 ft away from power entrance pole.

Wall plug-in outlets shall be installed as indicated on the plans. Where multiple outlets are to be provided, wall plate shall contain a balancing terminator resistor to assure a balanced circuit at all times.

TV lead-in wire shall be 300-ohm type of grade (. . .) or better and shall be kept a minimum of 12 in. away from any metal surface by use of insulated TV wiring stand-offs.

Where wiring is to be enclosed in a metal raceway, properly shielded cable shall be used. Wire shall be run in continuous lengths free of any splices. Connect outlets when plates are installed.

10.95 Hi-Fi Sound Systems

Furnish and install a (trade name or catalog number) high-fidelity sound reproduction system as manufactured by the . . . . . . Company, or approved equal. Installation shall be as indicated on the plans and in accordance with manufacturer's recommendations. (See Section 11.0 Signal, Communications and Auxiliary Systems for detailed specifications.)

11.0 Signal, Communications and Auxiliary Systems

11.1 Intercommunicating Telephone Systems

A. Two-station.
B. Master selective ringing and common talking.
C. Master selective ringing and common talking, program and signal control.
D. Selective ringing and common talking.
E. Selective ringing and selective talking.
F. Private exchange, manual board.
G. Private exchange, automatic switching.
H. Apartment selective ringing and common talking, vestibule to apartments, apartments to door-opener. (1) loudspeaking system, (2) non-loudspeaking system.

11.11 General

Furnish and install an (trade name and/or number) intercommunicating telephone system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first-class operating condition.

11.12 Operation

A. Two-station system: At the two locations shown, there shall be a telephone arranged so that one station may call and converse with the other. A pushbutton shall be provided with each unit. Pressing the button at one station shall ring the bell at the other station. Lifting the handphone (or receiver) completes the talking circuit.

B. Master selective ringing and common talking: In the main office where shown, there shall be a master telephone with pushbuttons (or selector switch) to selectively call any outlying telephone. At other locations the telephone shall have a pushbutton to call the master station. The master station after being called by an outlying station may call another outlying station to complete a connection between the two remote points. Only one conversation at a time is required.

C. Master selective ringing and common talking, program and signal control: In the main office where shown, there shall be a master telephone with pushbuttons to selectively call any outlying telephone by sounding the same buzzer in classroom clocks and bells at other locations as are used in the program system. At all other locations, except in principal's office, the telephone shall be furnished without a pushbutton or audible signal. Lifting the receiver on any outlying telephone shall sound a buzzer at the master telephone which is silenced by lifting the master telephone's handset. The master station after being called by an outlying station may signal another outlying station by pushing its corresponding pushbutton. When this station answers, the handset at the master is replaced on its hook (unless a 3-way conversion is desired) and a switch on the master is thrown to silence its buzzer. When the conversation between the two outlying phones is completed, the buzzer in the master shall sound as a reminder that the buzzer switch shall be returned to its normal position. Only one conversation at a time is required; however, as many outlying phones as desired may be on the line at the same time by the master

CHECK LIST

☐ **Intercommunicating Telephone System**
  - — general
  - — operation
  - — equipment
  - — terminal strip cabinets
  - — power supply
  - — wiring

☐ **Sound System**
  - — general
  - — functions and facilities
  - — equipment
  - — wiring

☐ **Fire Alarm System**
  - — general
  - — operation
  - — equipment
  - — wiring

☐ **Paging System**
  - — general
  - — operation
  - — equipment
  - — terminal strip cabinets
  - — wiring

☐ **Clock System**
  - — general
  - — operation
  - — equipment
  - — power supply
  - — wiring

☐ **Program Signal System**
  - — general
  - — operation
  - — equipment
  - — power supply
  - — wiring

☐ **Nurses' Calling System**
  - — general
  - — operation
  - — equipment
  - — wiring

☐ **Television Antenna System**
  - — general
  - — equipment
  - — power supply
  - — wiring

☐ **Closed Circuit TV**
  - — equipment
  - — wiring

☐ **Public Telephone System**
  - — general
  - — terminal strip cabinets

SIGNAL SYSTEM CABLES

Rubber and Lead

No. 18—1/64" RL*				No. 18—1/32" RL				No. 16—1/64" RL*				No. 16—1/32" RL			
Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Conduit Size
0.56	0.243	4/64"	1"	0.69	0.377	4/64"	1¼"	0.61	0.292	4/64"	1"	0.73	0.416	4/64"	1¼"
0.70	0.385	4/64"	1¼"	0.90	0.636	5/64"	1½"	0.76	0.454	4/64"	1¼"	0.96	0.723	5/64"	1½"
0.82	0.528	4/64"	1¼"	1.05	0.864	5/64"	2"	0.92	0.665	5/64"	1½"	1.12	0.985	5/64"	2"
0.94	0.680	5/64"	1½"	1.17	1.076	5/64"	2"	1.02	0.817	5/64"	2"	1.28	1.288	6/64"	2"
1.03	0.833	5/64"	2"	1.32	1.367	6/64"	2½"	1.12	0.985	5/64"	2"	1.41	1.563	6/64"	2½"
1.10	0.950	5/64"	2"	1.41	1.563	6/64"	2½"	1.20	1.130	5/64"	2"	1.51	1.791	6/64"	2½"
1.21	1.147	5/64"	2"	1.55	1.885	6/64"	2½"	1.35	1.413	6/64"	2½"	1.66	2.168	6/64"	3"
1.29	1.304	6/64"	2"	1.61	2.035	6/64"	3"	1.40	1.539	6/64"	2½"	1.76	2.435	7/64"	3"
1.33	1.390	6/64"	2½"	1.68	2.199	6/64"	3"	1.46	1.673	6/64"	2½"	1.83	2.631	7/64"	3"
1.42	1.571	6/64"	2½"	1.82	2.592	7/64"	3"	1.55	1.885	6/64"	2½"	1.95	2.985	7/64"	3½"
1.54	1.885	6/64"	2½"	1.98	3.063	7/64"	3½"	1.69	2.246	6/64"	3"	2.12	3.526	7/64"	3½"
1.68	2.199	6/64"	3"	2.15	3.628	7/64"	3½"	1.86	2.717	7/64"	3"	2.34	4.304	8/64"	4"
1.82	2.592	7/64"	3"	2.33	4.265	8/64"	4"	1.99	3.110	7/64"	3½"	2.50	4.909	8/64"	4"
1.93	2.906	7/64"	3"	2.47	4.791	8/64"	4"	2.11	3.495	7/64"	3½"	2.66	5.553	8/64"	4½"

* Approved by special permission only.

Signal and Communication Wiring Data

Wire sizes, dimensions and raceway data for types of conductors commonly used on signal, alarm and communication systems. Systems operating at substantial voltages and currents derived from power or lighting circuits are subject to code rules. On low voltage circuits line drop may also become a critically important consideration.

SINGLE TELEPHONE CABLE

No. Cond.	Single No. 22 & 4 Single No. 18					
	Braided			Leaded		
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size
6	0.26	0.053	½"	0.30	0.071	½"
11	0.28	0.061	½"	0.33	0.086	½"
16	0.31	0.075	½"	0.36	0.102	½"
26	0.36	0.102	½"	0.40	0.126	¾"
35	0.40	0.126	¾"	0.45	0.159	¾"
45	0.44	0.152	¾"	0.48	0.181	¾"
55	0.46	0.165	¾"	0.51	0.204	¾"
65	0.51	0.204	¾"	0.55	0.236	1"
75	0.53	0.219	1"	0.59	0.255	1"
85	0.55	0.236	1"	0.60	0.283	1"
100	0.60	0.283	1"	0.64	0.322	1"

PAIR TELEPHONE CABLE

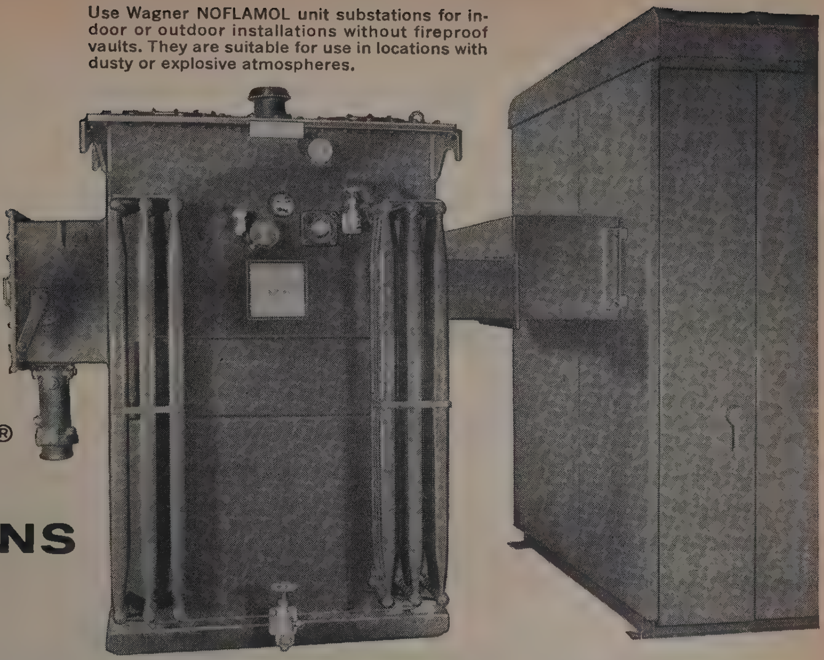
No. Pairs	Pairs No. 22 & 2 Pairs No. 18						Pairs No. 22 Only					
	Braided			Leaded			Braided			Leaded		
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size
6	0.36	0.102	½"	0.45	0.159	¾"	0.29	0.066	½"	0.33	0.086	½"
12	0.41	0.132	¾"	0.50	0.196	¾"	0.38	0.133	½"	0.42	0.139	¾"
16	0.50	0.196	¾"	0.59	0.273	1"	0.42	0.139	¾"	0.47	0.174	¾"
22	0.57	0.255	1"	0.66	0.342	1"	0.49	0.188	¾"	0.53	0.220	1"
32	0.62	0.302	1"	0.71	0.396	1¼"	0.57	0.253	1"	0.61	0.292	1"
41	0.74	0.430	1¼"	0.85	0.567	1¼"	0.61	0.292	1"	0.66	0.342	1"
51	0.88	0.608	1½"	0.97	0.739	1½"	0.70	0.385	1¼"	0.76	0.454	1¼"
65	0.92	0.665	1½"	1.01	0.802	2"	0.76	0.454	1¼"	0.83	0.541	1¼"
75	0.95	0.709	1½"	1.03	0.833	2"	0.82	0.528	1¼"	0.89	0.622	1½"
85	0.98	0.754	1½"	1.07	0.899	2"	0.86	0.581	1¼"	0.93	0.679	1½"
100	1.08	0.916	2"	1.16	1.057	2"	0.94	0.694	1½"	1.01	0.802	1½"
125	1.18	1.094	2"	1.26	1.247	2"	1.01	0.802	1½"	1.08	0.916	2"
150	1.27	1.254	2"	1.34	1.410	2½"	1.12	0.985	2"	1.18	1.094	2"
175	1.37	1.474	2½"	1.44	1.624	2½"	1.18	1.094	2"	1.25	1.227	2"
200	1.45	1.649	2½"	1.57	1.938	3"	1.27	1.254	2"	1.34	1.410	2½"

DUPLEX & TRIPLEX

Size AWG	Insulation Rubber Braid		Maximum Conductors in Conduit					
	Over. Diam.	Approx. Area Sq. In.	½ in. Int. Area .30 Sq. In.	¾ in. Int. Area .53 Sq. In.	1 in. Int. Area .86 Sq. In.	1¼ in. Int. Area 1.50 Sq. In.	1½ in. Int. Area 2.04 Sq. In.	2 in. Int. Area 3.36 Sq. In.
22*	.20	.031	6	12	20	36	50	84
22†	.22	.038	9	15	24	45	60	102
19*	.24	.045	4	8	14	24	34	68
19†	.26	.053	6	9	18	33	45	75

Note: * 2 Wire twisted.
† 3 Wire twisted.

Use Wagner NOFLAMOL unit substations for indoor or outdoor installations without fireproof vaults. They are suitable for use in locations with dusty or explosive atmospheres.



For better power distribution Use WAGNER® UNIT SUBSTATIONS

They are complete, coordinated load centers that give continuous, dependable power now . . . have plenty of capacity and flexibility for growth

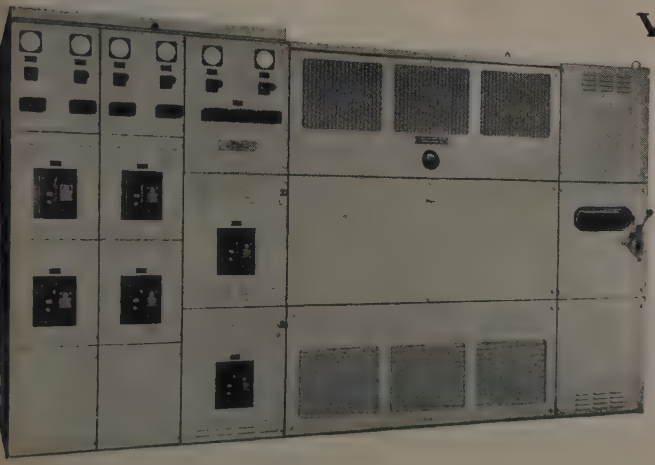
An uninterrupted flow of power . . . that's the important thing in buildings, be they sprawling single-story factories or high-rise offices. And that is what Wagner® unit substations provide.

Designed to improve voltage regulation, and built to be troublefree, they are coordinated load centers that provide the flexibility needed to meet future load requirements. They consist of a proved Wagner transformer, universally acceptable interrupting devices, highly reliable air break switchgear, and metering equipment combined in perfect power packages. To simplify installation, they are factory tested and shipped completely assembled, ready for service. They economically deliver utilization voltage with shorter, less expensive conductor runs . . . lower maintenance costs with modern, protective enclosures . . . safeguard valuable equipment with adequate interrupting capacity. And, substation investment is protected because *one* manufacturer has responsibility for all component parts.

Wagner unit substations are built with transformers rated 112½ through 2000 kva, 3-phase, 60 cycle ratings with high voltages of 2400, 4160, 4800, 6900, 7200, 12000, 13200, or 13800 volts and low voltages of 240, 208Y/120, 480 or 480Y/277 volts.

Four types per NEMA standards are available: sealed dry-type; ventilated dry-type; oil-filled; and Noflamol (non-inflammable liquid-filled).

Wagner Electric Corporation
6413 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U.S.A.



Your Wagner Sales Engineer

will be glad to help you plan any power distribution system. Get complete information on Wagner unit substations from him, or write us for Bulletin TU-152.

Use Wagner VENTILATED DRY-TYPE unit substations indoors. They perform efficiently in any reasonably dry, dust-free, well-ventilated location. Lightweight makes them ideal for use in multi-story buildings.

WT61-8A

SIGNAL SYSTEM CABLES

Rubber Covered

No. Cond.	No. 18—1/64" R*			No. 18—1/32" R			No. 16—1/64" R*			No. 16—1/32" R		
	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size	Over. Diam.	Approx. Area Sq. In.	Conduit Size
10	0.49	0.188	¾"	0.61	0.292	1"	0.53	0.219	1"	0.65	0.330	1"
20	0.63	0.314	1"	0.80	0.503	1¼"	0.69	0.377	1¼"	0.85	0.565	1¼"
30	0.74	0.322	1¼"	0.94	0.691	1½"	0.81	0.518	1¼"	1.01	0.802	1½"
40	0.83	0.541	1¼"	1.06	0.880	2"	0.92	0.668	1½"	1.14	1.021	2"
50	0.93	0.675	1½"	1.18	1.094	2"	1.02	0.817	1½"	1.27	1.254	2"
60	1.00	0.785	1½"	1.28	1.288	2"	1.10	0.950	2"	1.38	1.492	2½"
70	1.10	0.950	2"	1.41	1.563	2½"	1.21	1.147	2"	1.53	1.838	2½"
80	1.15	1.037	2"	1.48	1.720	2½"	1.27	1.254	2"	1.60	2.011	3"
90	1.21	1.147	2"	1.54	1.861	2½"	1.32	1.367	2½"	1.67	2.191	3"
100	1.28	1.288	2"	1.66	2.168	3"	1.41	1.563	2½"	1.79	2.513	3"
125	1.40	1.539	2½"	1.82	2.592	3"	1.56	1.909	2½"	1.96	2.974	3½"
150	1.54	1.861	2½"	1.99	3.110	3½"	1.70	2.260	3"	2.15	3.628	3½"
175	1.66	2.168	3"	2.14	3.596	3½"	1.83	2.631	3"	2.31	4.163	4"
200	1.77	2.458	3"	2.28	4.084	4"	1.95	2.984	3½"	2.47	4.791	4"

* Approved by special permission only.

GROUPED SINGLE CONDUCTORS

Size AWG	Insulation RF.32, R, RH, RW*		Insulation TF, T, TW, RU* RUF, RUW		Insulation RF-64**		Maximum Number Conductors in Conduit							
	Over. Diam.	Approx. Area Sq. In.	Over. Diam.	Approx. Area Sq. In.	Over. Diam.	Approx. Area Sq. In.	½ in. Int. Area .30 Sq. In.	¾ in. Int. Area .53 Sq. In.	1 in. Int. Area .86 Sq. In.	1¼ in. Int. Area 1.50 Sq.In.	1½ in. Int. Area 2.04 Sq.In.	2 in. Int. Area 3.36 Sq.In.	2½ in. Int. Area 4.79 Sq.In.	3 in. Int. Area 7.38 Sq.In.
18	.146	.0167	.106	.0088			7	12	20	35	49	80	115	176
18					.100	.0079	14	24	42	73	100	165	236	364
16	.158	.0196	.118	.0109			6	10	17	30	41	68	97	150
16					.113	.0100	12	19	33	58	79	131	186	287
14	.171	.0230	.131	.0135			4	6	10	18	25	40	59	90
12	.188	.0278	.148	.0172			3	5	8	15	21	35	50	77
10	.242	.0460	.168	.0224			2	4	7	13	17	29	41	64
8	.311	.0760	.228	.0408			1	3	4	7	10	17	25	38
6	.397	.1238	.323	.0819			1	1	3	4	6	9	15	23

Combination of Conductors

	*	**
1—No. 14 Equal to	1—No. 18 or 1 No. 16	3—No. 18 or 2 No. 16
2— " " " "	2— " " " 2 " "	5— " " " 4 " "
3— " " " "	4— " " " 3 " "	8— " " " 7 " "
1— " 12 " "	1— " " " 1 " "	3— " " " 3 " "
2— " " " "	3— " " " 3 " "	7— " " " 5 " "
3— " " " "	4— " " " 4 " "	10— " " " 8 " "

Note: *In accordance with NEC.
**Approved by special permission.

Above sizes apply to straight runs or with nominal offsets equivalent to not more than two quarter-bends

PAGING SYSTEM CABLES

No. Cond.	No. 14—3/64" R			No. 12—3/64" R			No. 14—3/64" RL				No. 12—3/64" RL			
	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Cond. Size	Over. Diam.	Approx. Area Sq. In.	Thick Lead	Cond. Size	Over. Diam.	Approx. Area Sq.In.	Thick Lead	Cond. Size
12	0.84	0.554	1½"	0.94"	0.680	1½"	0.97"	0.738	5/64"	1½"	1.05	0.864	5/64"	2"
20	1.10	0.950	2"	1.19"	1.112	2"	1.20"	1.130	5/64"	2"	1.32	1.367	3/32"	2½"
24	1.21	1.147	2"	1.31"	1.348	2"	1.35"	1.420	5/64"	2½"	1.45	1.649	3/32"	2½"

signaling the desired phone for a conference. It shall be possible at the master station to transfer the audible signals from one program circuit to another without disturbing the overall program setting or the wiring.

D. Selective ringing and common talking system: At each location shown, there shall be a telephone arranged for calling and conversing with any other telephone in the system. Each station shall be provided with pushbuttons (or selector switch) for selectively ringing any other station. Only one conversation at a time is required.

E. Selective ringing and selective talking system: At each location shown, there shall be a telephone arranged for calling and conversing with any other telephone in the system. Each station shall be provided with pushbuttons (or selector switch) for selectively ringing and selectively talking with any other station in the system. It shall be possible to use several telephones simultaneously for a conference provided that the call station is not preoccupied.

F. Private exchange, manual switchboard system: In the switchboard operator's room, there shall be a common-return, lamp-signal-type manual switchboard arranged to call and interconnect any telephone in the system. At other locations where shown, there shall be a telephone of the type designated by the symbol. The telephone operator may call and converse with any outlying station, and any outlying station may call and converse with the operator, or be connected through the switchboard so that two outlying telephones may converse. Removing the handphone (or receiver) on any outlying station will cause its associated lamp to light at the switchboard. Connection from one line to another may be made by inserting the plugs of the cross-connecting cords into the calling and called station-line jacks. Operator listens and converses through a headset and breast-plate transmitter or handset, connecting into individual cross-connecting sets by means of listening and ringing keys. Each set of cross-connecting cords shall be provided with supervisory lamps to indicate completion of a conversation between two stations. A buzzer and silencing switch shall be provided as a night signal.

G. Private exchange, automatic switching system: In the machine room in basement, there shall be a complete automatic exchange unit. This shall consist of an automatic relay (or step-by-step) switching unit,

[Continued on page 206]

AIA FILE NO. 31-C-7

IT PAYS TO HAVE GOOD CONNECTIONS
HUBBELL
RUGGED WIRING DEVICES

SPECIFICATION

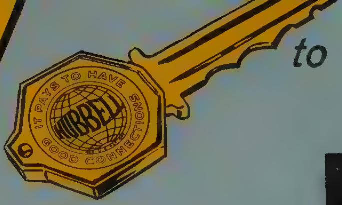
KEY

TO GROUNDING SAFETY AND SECURITY

A complete line of rugged specification grade grounding devices for every building requirement. (Meets all requirements of American Standard ASA C-73a and Underwriters' Laboratories, Inc. "Standards for Safety", all applicable Federal, NEMA and REA specifications.)

ARVEY HUBBELL, INCORPORATED, BRIDGEPORT 2, CONNECTICUT

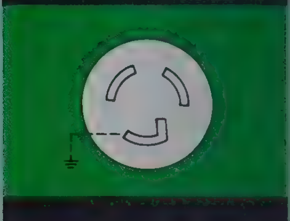
KEY


IT PAYS TO HAVE GOOD CONNECTIONS
HUBBELL

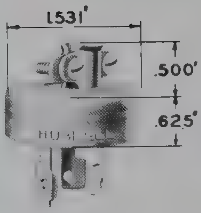
to fast, trouble-fre

125 VOLT
GROUNDING ONLY
Twist-Lock®
WIRING DEVICES

15a. 125v.



CAPS AND BODIES



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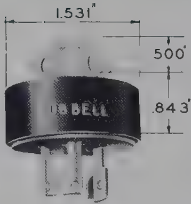

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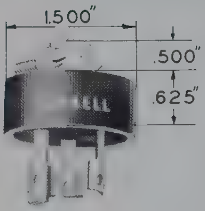
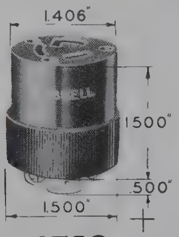


4723

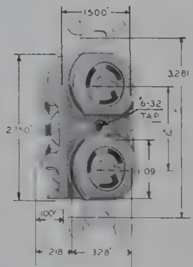
Note the special 4700 line configuration with distinctive elbow-shaped grounding slot. This prevents insertion of regular "Twist-Lock" caps, accepting 4700 Series caps with elbow-shaped grounding blade only.



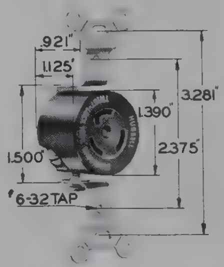
4730

The 4700 Series is the only "Twist-Lock" device approved as meeting Code requirements for 125-volt grounding. Each unit is easily identified by its brown color. In other respects the 4700 line has the same rugged quality features built into the regular "Twist-Lock" line. The 4700 receptacle has easy-to-spot green hexagonal grounding screws. Exclusive Hubbell pressure grip back wiring is provided.

RECEPTACLES



4700



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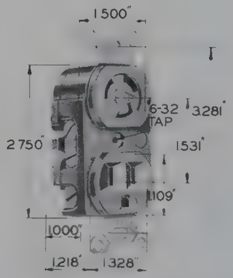
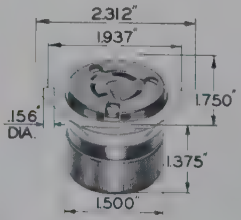


4792

BASES



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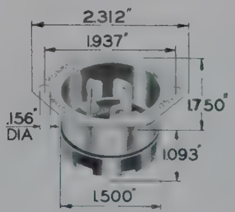
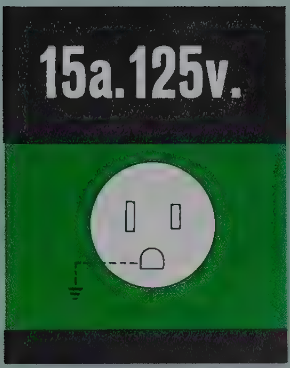
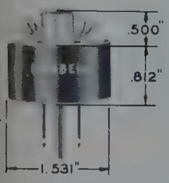


4716

stallation and lasting job security



GROUNDING DEVICES PARALLEL BLADE WITH U-SHAPED GROUND



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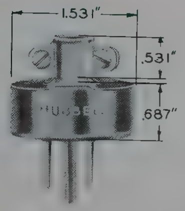
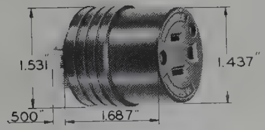


5264

5274

5280

5269



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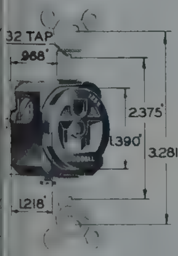

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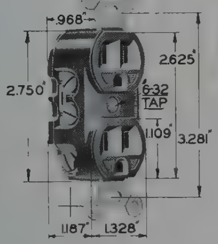

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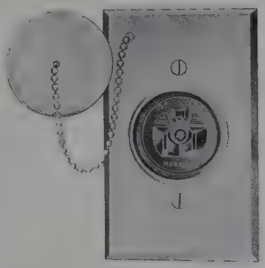
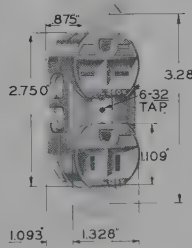


5260

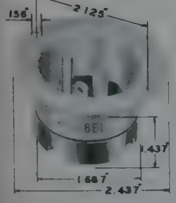
SG-62-1



COMBINATION

5292

5261
with
5661



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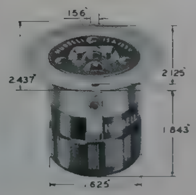

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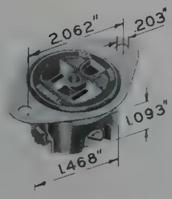

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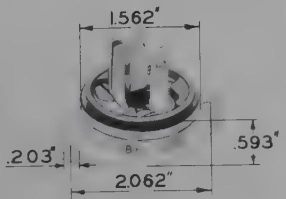

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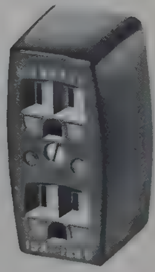


Grounding Adapter

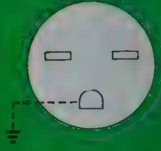
5291

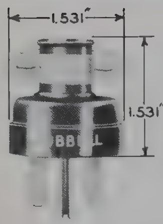
KEY

to fast, trouble-fre

GROUNDING DEVICES
TANDEM BLADE
WITH
U-SHAPED GROUND

15a. 250v.





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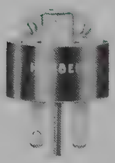

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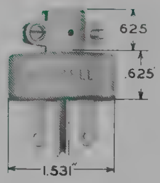

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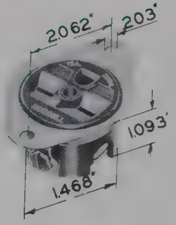

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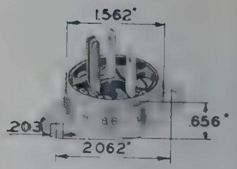

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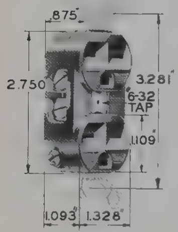

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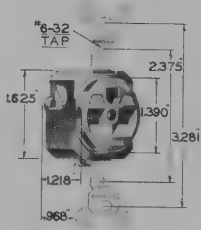

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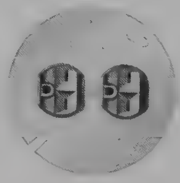

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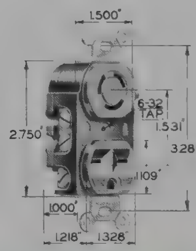
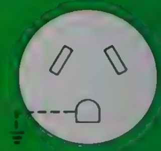


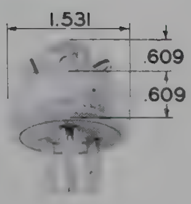
COMBINATION
(standard T-L w. 5661)

7375

15a. 277v.

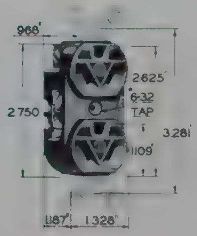


GROUNDING DEVICES
STRAIGHT BLADE



***5314**

5303



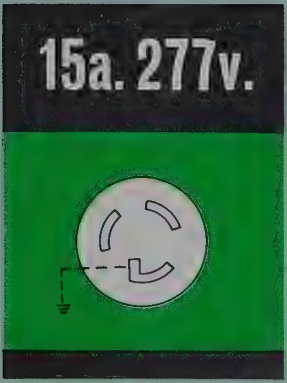
5302

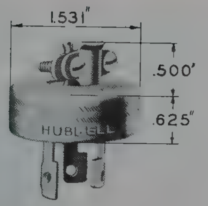
* *In development, available shortly.*

installation and lasting job security

277 VOLT
GROUNDING ONLY
Twist-Lock®
WIRING DEVICES

DESIGNED FOR FLUORESCENT LIGHTING APPLICATIONS





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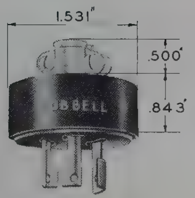
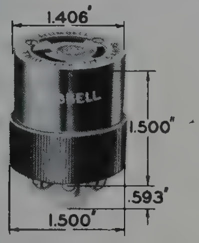


4770

Non-interchangeable with regular "Twist-Lock" devices, 4700 Series, grounding (15 amp., 125 volt) "Twist-Lock" devices, or any other devices on the market.



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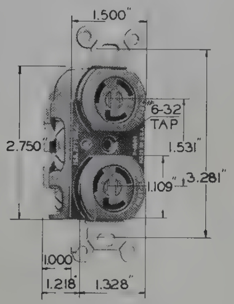

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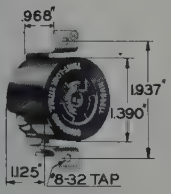

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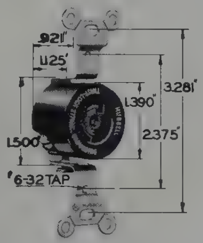
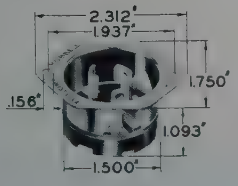


4760

4751

. . . the only 15 amp., 277 volt duplex locking and grounding receptacle on the market . . . feeds two fluorescent fixtures from one single gang box . . . cuts number of receptacles and boxes in half . . . saves hours of installation and maintenance time.



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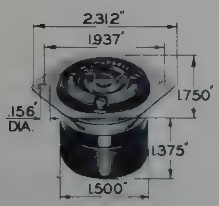
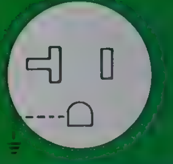


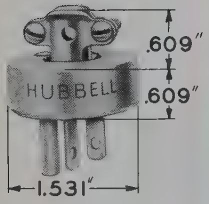
4785

GROUNDING DEVICES
STRAIGHT BLADE
WITH
U-SHAPED GROUND

20a. 125v.

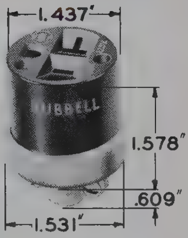


CAPS



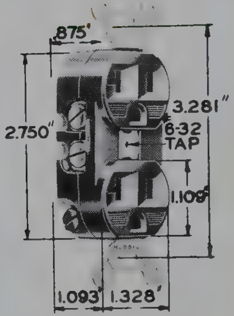
***5364**

BODIES



5374

RECEPTACLES



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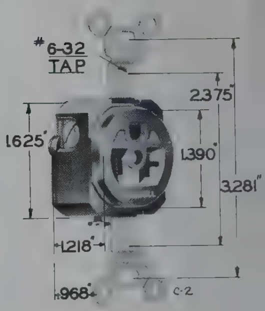
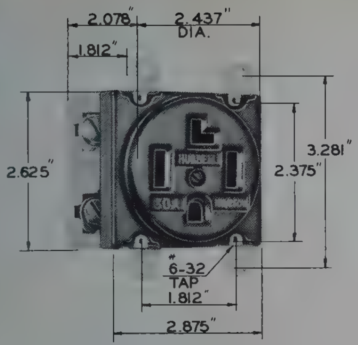


5361

5363

** In development, available shortly.*

KEY *to fast, trouble-free installation and lasting job security*



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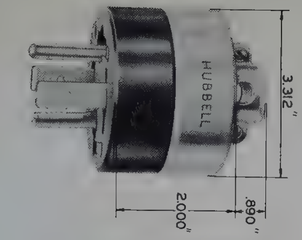

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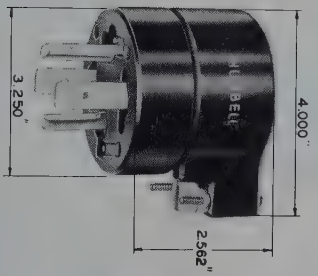
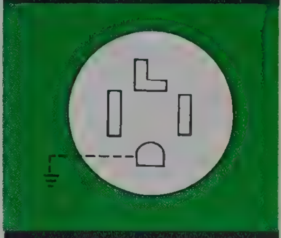
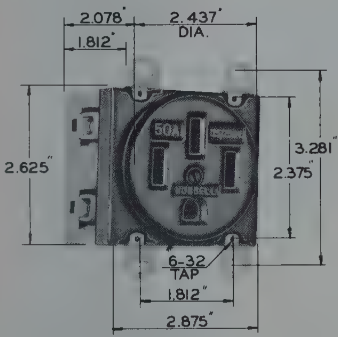


9432

30a.
125/250v.





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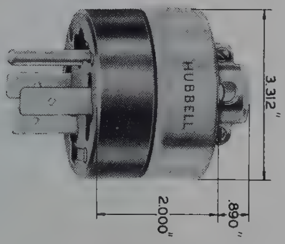

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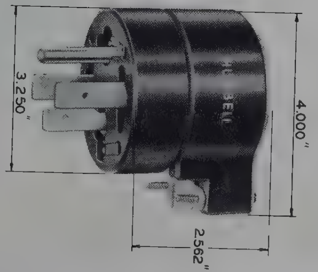
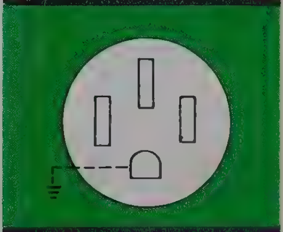
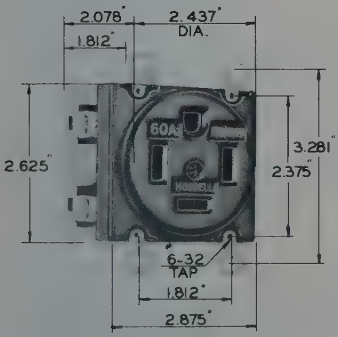


9452

50a.
125/250v.





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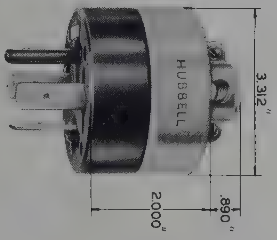

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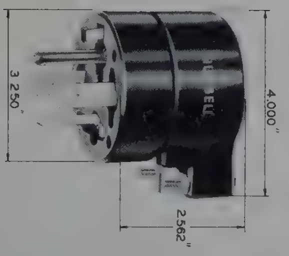
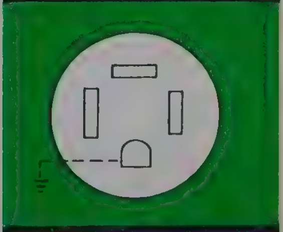


9462

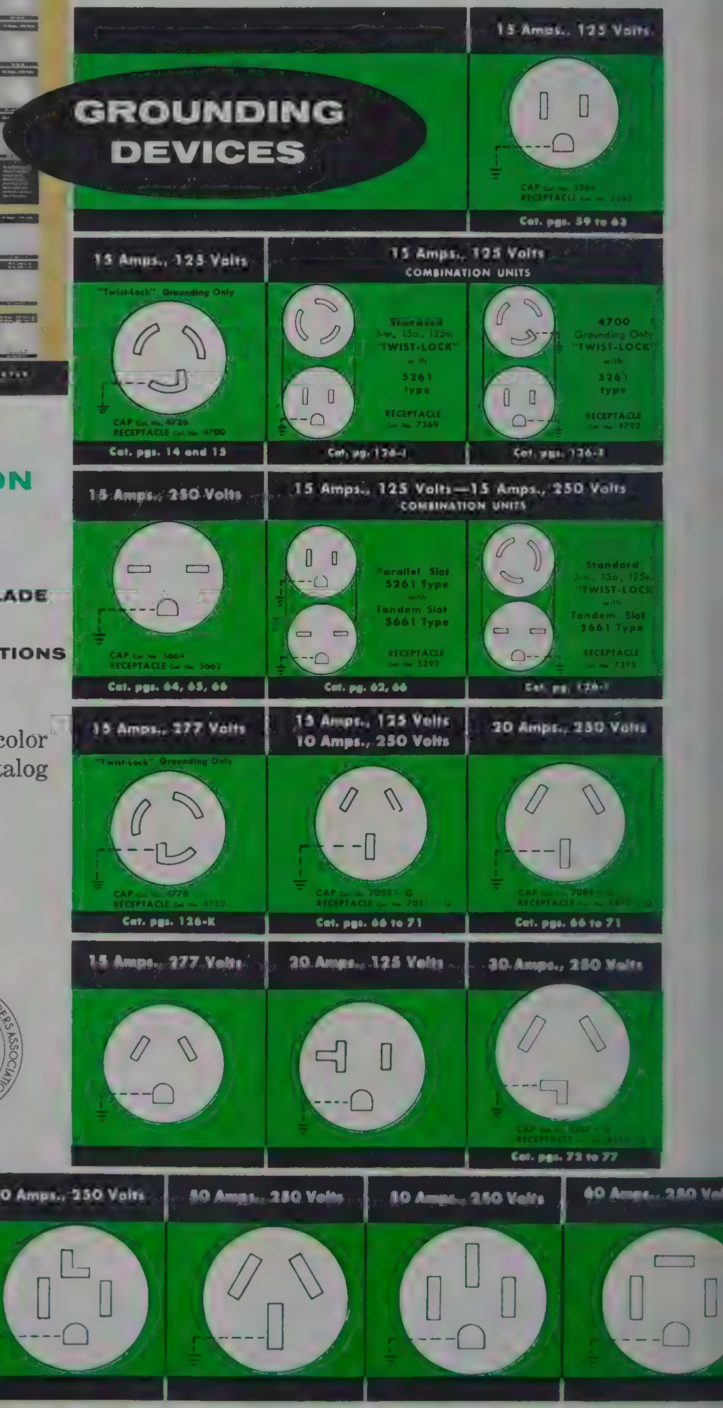
60a.
125/250v.



specifying is faster, easier . . . with this

CONFIGURATION CHART

Grounding section of chart, enlarged.



FREE CONFIGURATION CHART

OF

GROUNDING, STRAIGHT BLADE "TWIST-LOCK" AND "HUBBELLOCK" CONFIGURATIONS

Write Hubbell Advertising Department for free color coded 8½″ x 11″ chart showing: 1. ratings 2. catalog numbers of matching caps and receptacles.

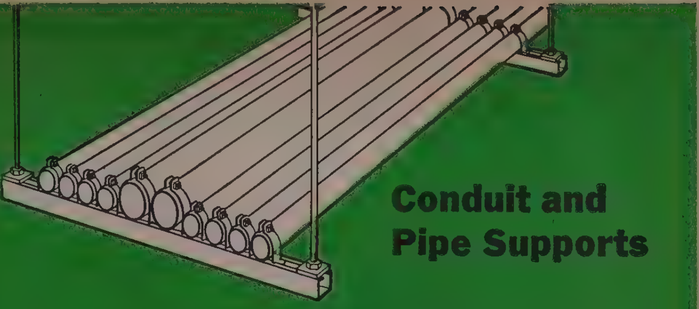
IT PAYS TO HAVE GOOD CONNECTIONS

HARVEY HUBBELL, INCORPORATED

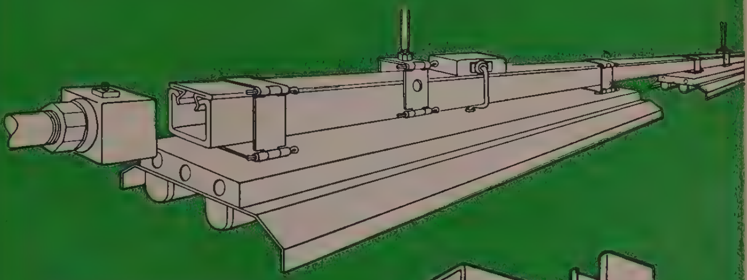
Rugged Wiring Devices

Bridgeport 2, Connecticut
In Canada: Scarborough, Ontario
In England: Camberley, Surrey

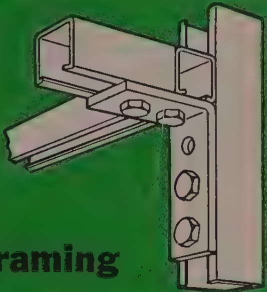
STEEL CITY'S CHANNEL AND SUPPORTS



Conduit and Pipe Supports



Fluorescent Fixture Raceway and Support



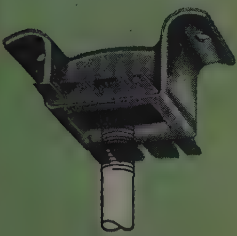
Metal Framing

THE KINDORF METHOD

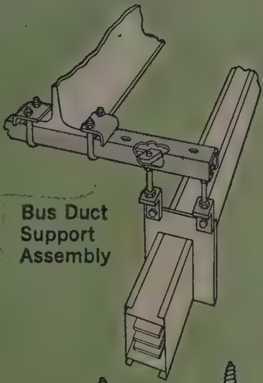
GALV-KROM FINISH

An electrogalvanized finish
PLUS added protection of zinc chromate

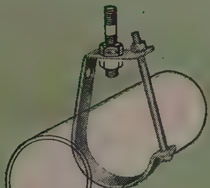
and accessories too . . .



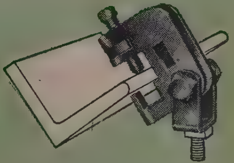
D-255 Concrete Insert



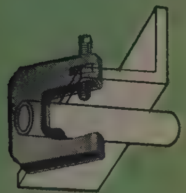
Bus Duct Support Assembly



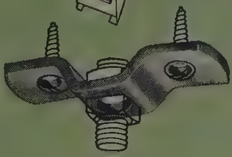
C-149 Series Conduit Hangers



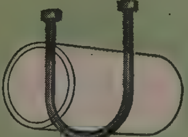
E-232 Clamp with Swing Connector



C-247 Conduit Clamp



E-243 Wood Beam Support Flange



H-286 Series U-Bolts

Hanger Rods

H-195 Steel Rod Coupling

SOLD THROUGH WHOLESALE DISTRIBUTION ONLY

Refer to Sweets Catalog files or write for product information

Write for new Steel City Handbook

STEEL CITY ELECTRIC COMPANY
A subsidiary of American-Marietta Company
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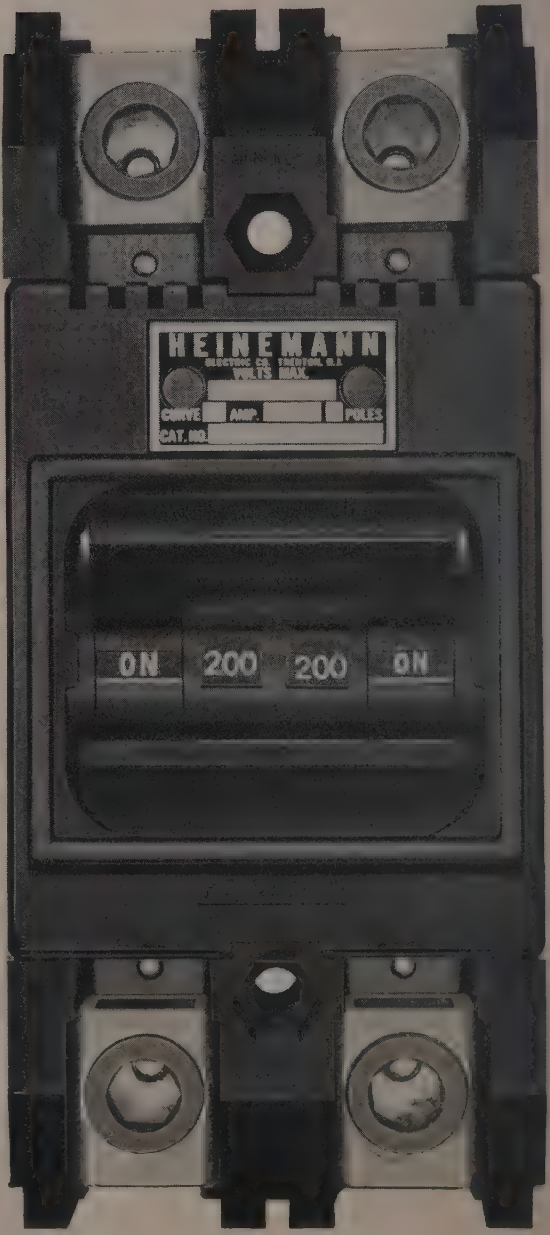
NOW...200-AMPERE CAPACITY IN ABOUT 50% LESS SPACE



Shown here, actual size, is Heinemann's SE-33 circuit breaker. It's about half the size of any other breaker that can be used for 200-amp service. • In a panelboard, it saves several inches. In its own enclosure (indoor or outdoor), it's more compact than equivalent fused safety switches or service-entrance pullouts. The SE-33 is the only 200-amp breaker built on a 200-amp frame (others use a 225-amp frame). This makes it smaller. And less expensive. It's also easy to install. Its terminals accept copper or aluminum conductors in the range of #6—#250, CM CU/AL. It has pressure-type solderless connectors. • The SE-33 is a two-pole breaker, available in ratings of 125, 150, 175, and 200 amperes, 120/240 V, AC. It always carries full-rated current because it's magnetically actuated. It never has to be derated for high ambient temperatures. All the details are in Bulletin 1003. We'll be glad to send you a copy.

HEINEMANN ELECTRIC COMPANY **132 BRUNSWICK PIKE, TRENTON 2, N. J.**

SA 2434

t Convincing Tribute to HOLOPHANE LIGHTING QUALITY.

Fischbach & Moore, Inc., New York

Leaders in the Architectural and Engineering Fields

SPECIFY and USE

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Prismatic Luminaires

Johnson & Johnson Engineers-Architects, Inc., Chicago, Ill.

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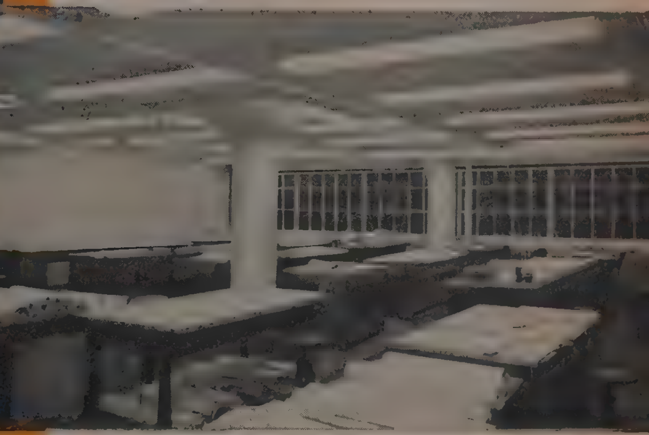

U.S. Corps of Engineers, Boston, Mass.

New York headquarters as well as in the
ld Holophane maintains a staff of competent
hting engineers. Their major efforts are devoted
working with those who are involved with the
oblems of building design and construction.

rough long experience and concentrated
owledge they are highly qualified to assist
gineers and Architects in the preparation of
ailed lighting proposals for presentation to
nts and prospects.

y save engineering departments considerable
e and money by developing layout designs,
tcandle calculations, cost comparisons,
inaire specifications—everything pertaining
he solution of a given lighting problem.

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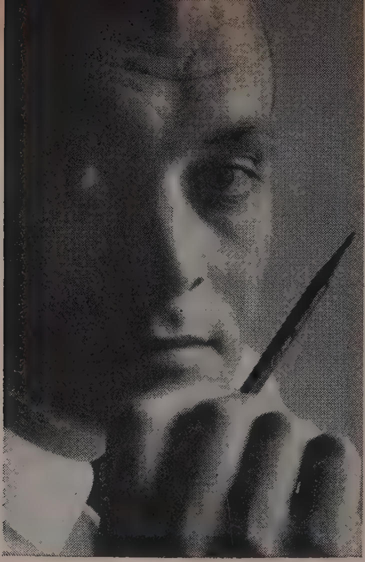
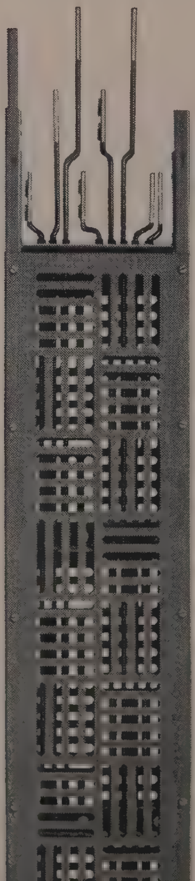
COMPANY, INC. • *Lighting Authorities Since 1898*
342 Madison Ave., New York 17, N. Y.
THE HOLOPHANE CO., LTD., 418 KIPLING AVE. SO., TORONTO 18, ONTARIO



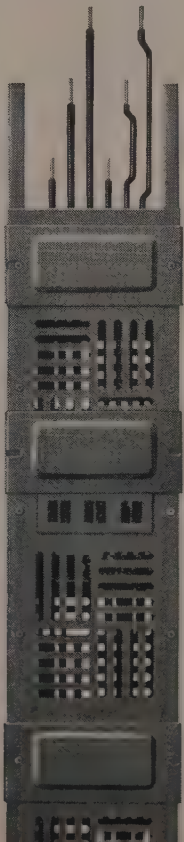
8 types of Westinghouse bus duct—WHY?

PLUG-IN . . . For industrial or commercial applications . . . 225- through 1000-ampere ratings. Plug-in outlets every 12 in. along run. Good for meeting changing requirements in industrial plants.

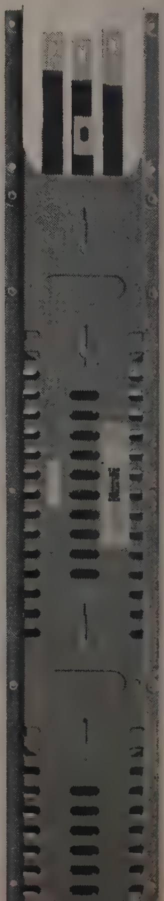
LOW IMPEDANCE . . . Maximum efficiency for long feeder runs . . . 600- through 5000-ampere ratings. Indoor or outdoor applications. A wide variety of special fittings makes this bus duct most flexible to meet special requirements.



PLUG-IN LOW IMPEDANCE . . . Combines the high efficiency of low impedance design plus the convenience of plug-in receptacles. Ratings 600 through 4000 amperes. Accepts standard 3-pole plug-in devices, interchangeable with conventional plug-in duct.



LIFE-LINE . . . A plug-in bus duct with the ultimate in safety features. The plug-in unit can be completely installed and wired before contact is actually made with the bus bars. Ratings 225 through 4000 amps.



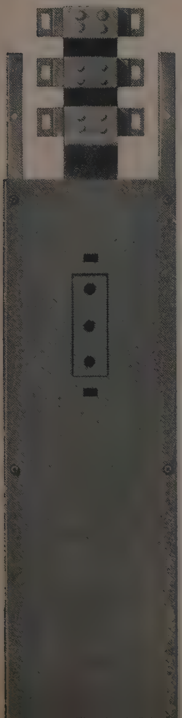
Simply because no **one** type will properly meet all duct applications. When the factors of voltage drop, frequency, over-all cost, capacity and plug-in features are weighed, it takes many types to do the job properly. That's why Westinghouse makes 8 specialized types of duct.

To the consulting engineer, this means the opportunity for optimum design; to the contractor it means fast installation; to the plant engineer it means power savings and low maintenance.

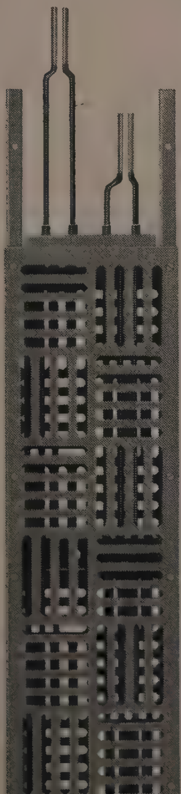
Want complete information on how these 8 types of Westinghouse bus duct can provide a long and useful life for a new building or a new lease on life for an old one? Contact your Westinghouse representative or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. J-30322

Westinghouse

HIGH-FREQUENCY... Most efficient of all power distribution systems for high-frequency application—400 cycles and above. Voltage drop of less than 1 volt per 100 ft at full load. Has plug-in convenience for easy power take-off. Typical applications include aircraft or electronic manufacturing, induction heating and many others.

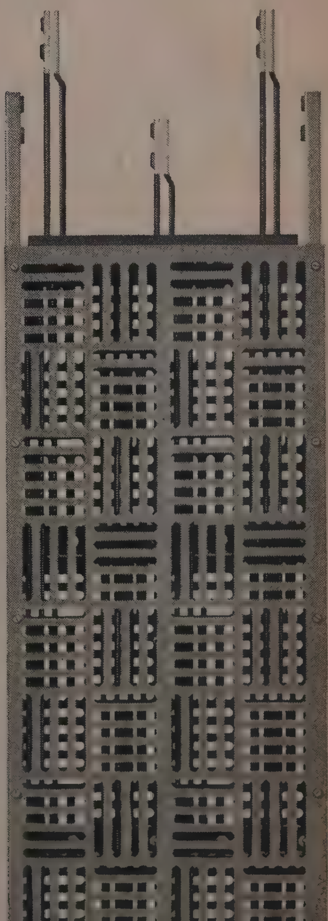


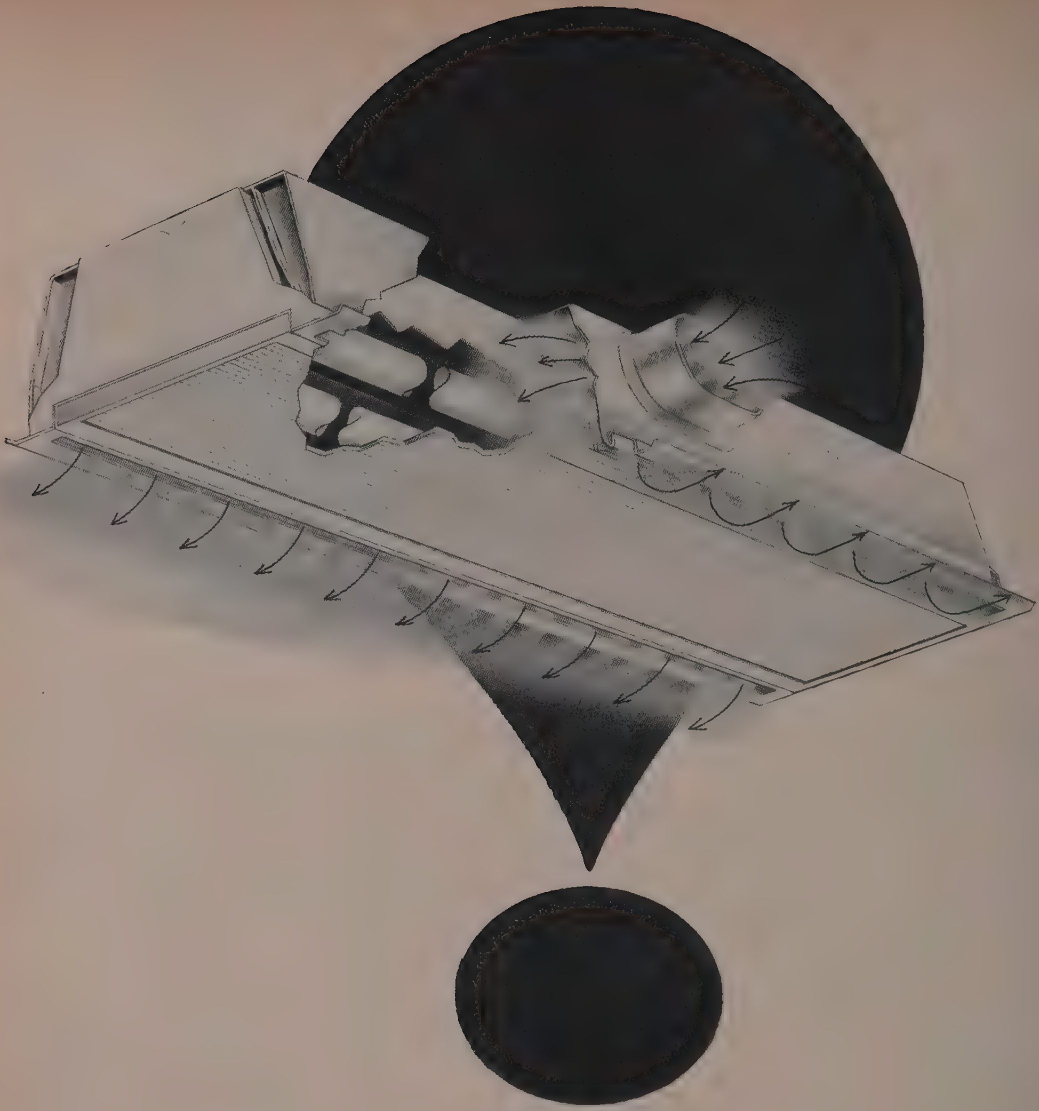
D-C (Electric Utility) . . . Specially for the distribution of direct current in power plants or factories. Available in ratings of 225 to 12,000 amperes. Uses include excitation service for turbine generators, telephone exchanges, battery charging and plating facilities.



100-AMP . . . A new low-capacity, low-cost busway system designed for low current applications with all of the inherent advantages of bus duct. Has plug-in convenience, complete salvability, low installed cost. Fast installation possible because of snap-together joint and completely captivated hardware.

CURRENT LIMITING . . . A bus duct for use feeding from networks, designed specifically to limit the fault current to a value that conventional circuit protective devices can safely interrupt. Ratings 1000 to 4000 amps. Ideal for entrance runs. It also can be used in conjunction with other types of duct.





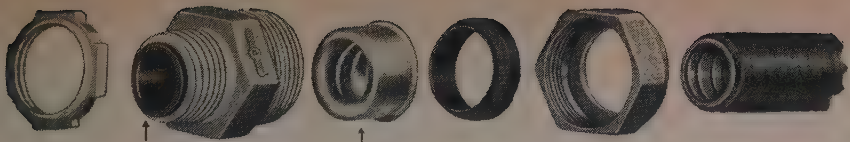
The fixture that leads 4 lives...

VENTRO-LUX

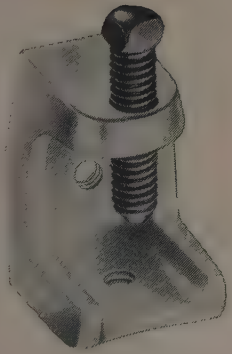
it provides light • heat • cooling • ventilation

As part of a 10 year product development plan, Curtis AllBrite presents a new fixture, the Ventro-Lux with Anemostat air-diffuser. Four essential services are provided in this combined unit—excellent diffusion of light plus the optimum in heating, cooling and ventilation. The exclusive CALux lens provides effective concealment of lamps, high light output plus attractive appearance. The separate Anemostat air-diffuser handles a high capacity of air which it diffuses horizontally along the ceiling. Result—draft-free distribution, no hot or cold spots, no ceiling smudge. The Ventro-Lux is the first troffer to be combined with a high capacity air-diffuser. Since the Ventro-Lux and Anemostat units are installed separately there is no conflict in the trades. Curtis AllBrite Lighting, Inc., 6135 W. 65th St., Chicago 38, Ill.—352 Shaw Road, South San Francisco, Calif.—Toronto, Canada—Vancouver, B. C., Canada.

CURTIS-ALLBRITE
LIGHTING, INC.
Visioneers in Planned Lighting



Malleable Iron Liquid-Tite Connectors



M.I. Beam Clamps

M.I. 90° Corner Adapters and Corner Elbows

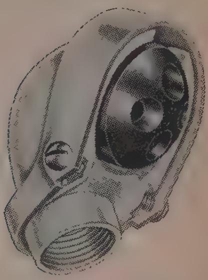
QUALITY MALLEABLE IRON FITTINGS ARE AVAILABLE!

GEDNEY'S

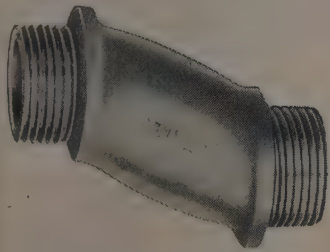
Complete Line is Precision-Made of Unbreakable Malleable Iron . . .

- *Unmatched for Toughness*
- *Impervious to Corrosion*

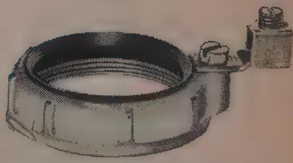
GEDNEY FITTINGS FIT



M.I. Entrance Caps



M.I. Offset Connectors and Offset Nipples



M.I. Insulated Bushings

GEDNEY
ELECTRIC COMPANY

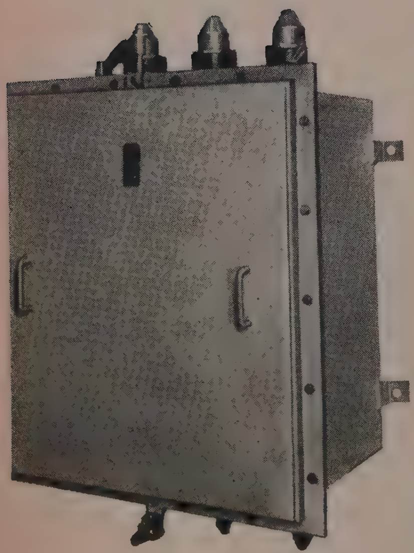
AMERICAS BLDG. • RADIO CITY • NEW YORK 20
Foundry, Factory and Shipping Point: Terryville, Conn.

M.I. Conduit Bodies

M.I. Armored Cable & Non Metallic Connectors

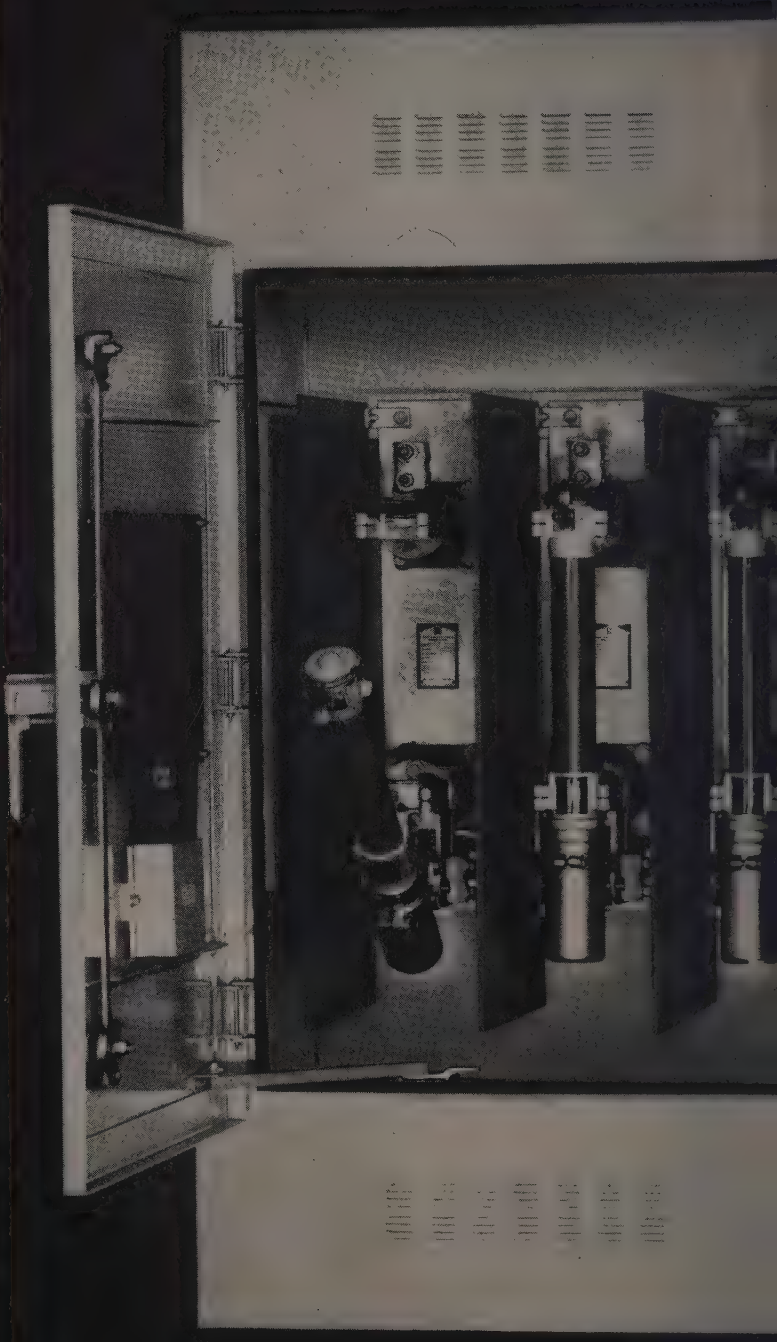
M.I. 3 Piece Conduit Couplings

Who ever heard of hanging 500,000 kva on a wall?



▲
Submersible style for use in basements or vaults where flooding is a possibility.

►
Indoor-outdoor style for general application where there is no possibility of flooding.



Do it with S&C's new line of high-voltage metalclad fuses for wall mounting

Here is a steel-enclosed fuse that gives you economical and fully adequate high-voltage fault protection for small loads:

1. *At service entrances;*
2. *On transformer primaries;*
3. *At underground sectionalizing points.*

S&C's new line of metalclad fuses combines economy with high fault interrupting capability. Their compactness permits wall mounting, eliminating the floor area requirements of conventional free standing metalclad switchgear. And much less room height is needed.

These fuses are especially suited to applications that justify fault protection *only*—applications where infrequent load switching (and isolation for rare fuse replacement) may be done elsewhere.

To permit you to tailor the new S&C Metalclad Fuse—Type SM to your particular requirements, a complete selection of features and ratings is available:

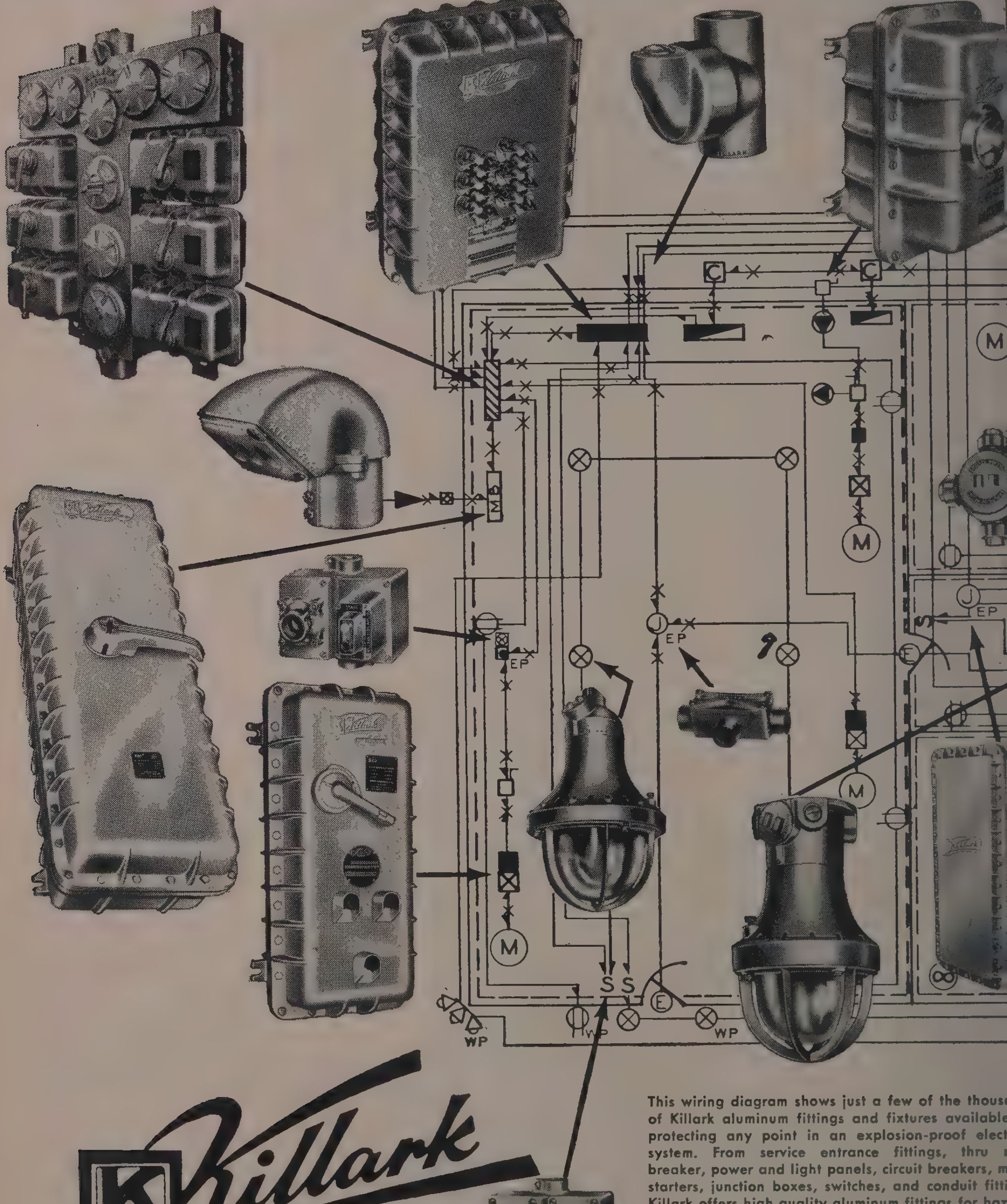
- Indoor Style, Indoor-Outdoor Style, or Submersible Style
- 4.8 kv or 14.4 kv
- 200E or 400E continuous amperes
- Cable entrance by knockout, flange-mounted pothead (1/C or 3/C), or integral pothead (1/C)
- 45,000 kva to 500,000 kva fault interrupting, in convenient steps

For further information, call your nearest S&C Sales Office. Consult the Yellow Pages under "Electrical Equipment" for the telephone number and address in all principal cities.

S&C ELECTRIC COMPANY
4433 Ravenswood Avenue • Chicago 40, Illinois
Specialists in High Voltage Circuit Interruption since 1911

S&C

Killark supplies all the explosio



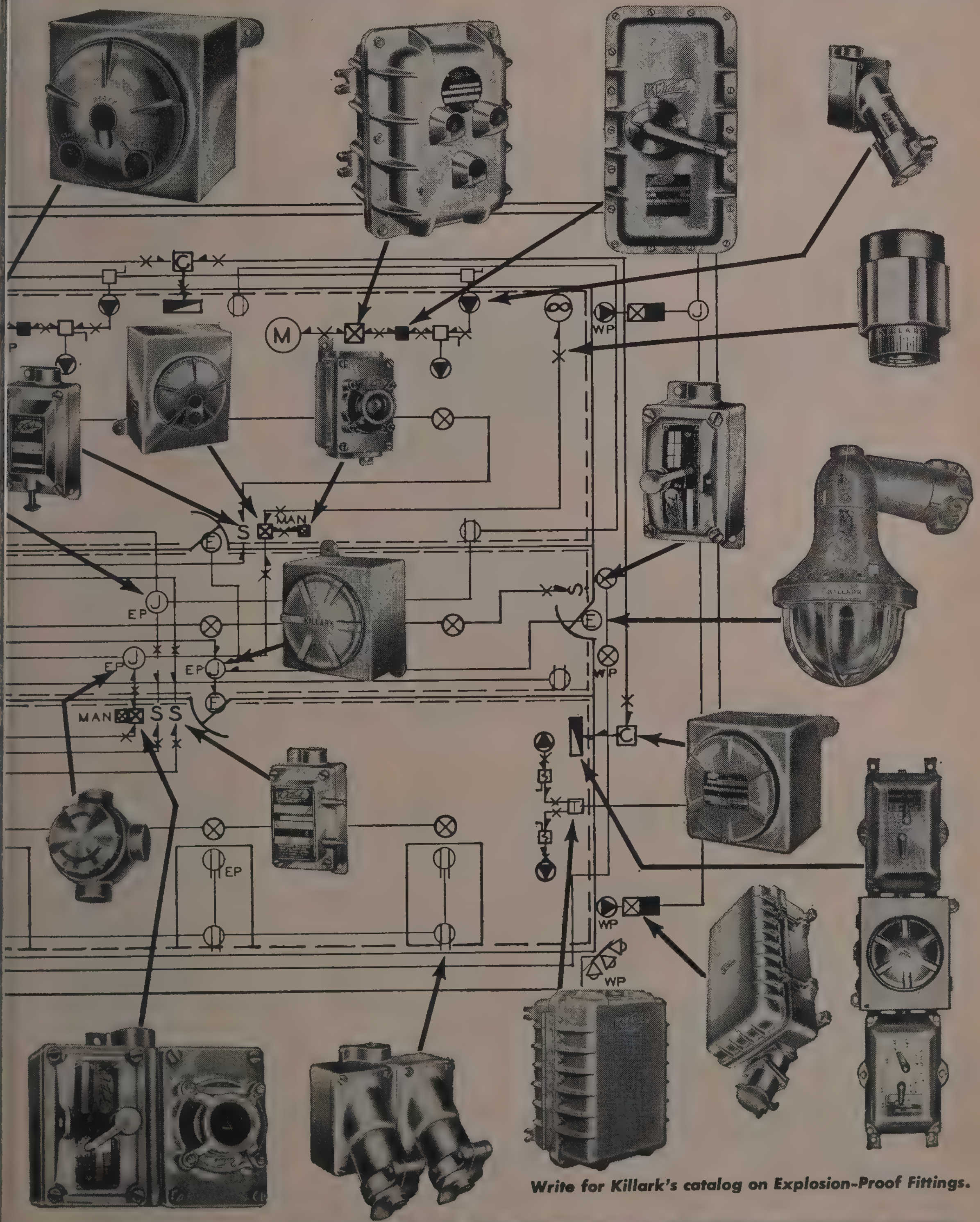
This wiring diagram shows just a few of the thous
of Killark aluminum fittings and fixtures available
protecting any point in an explosion-proof elect
system. From service entrance fittings, thru m
breaker, power and light panels, circuit breakers, m
starters, junction boxes, switches, and conduit fitti
Killark offers high quality aluminum fittings for haz
ous and non-hazardous areas. More than 4500 it
are supplied from stock at 19 convenient wareho
throughout the United States and Canada.

Killark

KILLARK
ST. LOUIS

ELECTRIC MANUFACTURING COMPANY
VANDEVENTER AND EASTON AVE. • ST. LOUIS 13, MO

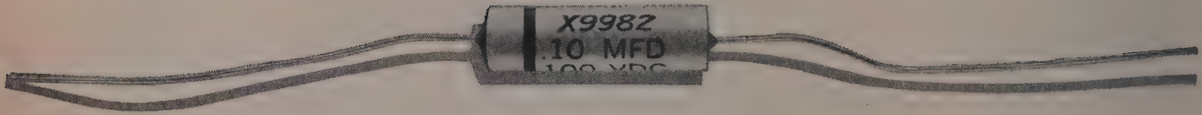
proof equipment you need...



Write for Killark's catalog on Explosion-Proof Fittings.

IT PAYS TO *SPECIFY* KILLARK ALUMINUM ELECTROLETS
FAST DELIVERY THRU WAREHOUSE STOCKS IN EIGHTEEN CITIES

B.F.Goodrich



"Quality assurance"

and lower costs, too

with tubes of rigid Geon

FAST tubular capacitors encased in tubes made of rigid Geon are manufactured by John E. Fast Company, Chicago. Picture shows test operation. Special attention is paid to humidity, even to the clothes and cosmetics operators wear. 100% of production is tested to provide constant information on product quality Tubes are extruded by Pyramid Plastics, Chicago, of rigid Geon supplied by B.F.Goodrich Chemical Company.

Because his capacitors are used in "Minuteman" missiles, this manufacturer pays extra attention to already high standards for reliability. He aims to a quality level 50 times better than normal industry goals. Maintaining this kind of quality can be costly. Instead, careful analysis of components which led to replacing paperboard tubes with tubes of rigid Geon vinyl helped improve reliability and cut costs at the same time.

The rigid Geon tube gives excellent dielectric characteristics. It assures that the case will never be the cause of a humidity problem. It will not corrode or be adversely affected by aging. The manufacturer has also found that rigid Geon tubing is easy to work with in assembly operations.

Here's another place where Geon vinyl is improving products, sometimes opening whole new markets. To learn about this and applications of Geon in other forms, write Department NQ-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

Geon
VINYLS

B.F.Goodrich Chemical
a division of The B.F.Goodrich Company

WIREMOLD® ELECTRIC IDEAS

PREPARED EACH MONTH FOR ELECTRICAL CONSTRUCTION AND MAINTENANCE TO BRING IDEAS, NEWS AND HELPFUL INFORMATION TO ELECTRICAL MEN

62nd YEAR **MAY 1961**

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CODE COMMENTS .... FIRST PAGE
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PERSONNEL NOTES .... THIRD PAGE
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USEFUL LITERATURE .... FOURTH PAGE
WORTH READING .... FOURTH PAGE
PRACTICAL TIPS .... FOURTH PAGE

Surface Systems Simplify School Wiring Problems

New construction as well as modernization is benefited by use of surface wiring systems for power and lighting

The tremendous increase in the use of electricity in schools — for emergency lighting, language labs, audio-visual aids, general lighting and power — has caused school boards to pay more attention than ever to electrical wiring in new construction and modernization programs.

From grade school to university, school planners are turning to surface wiring systems as the answer to many of the problems.

Solid type construction, such as cement block and laminated roof, is popular for low initial cost and flexibility for future expansion. Conventional wiring is difficult in this type of building and also may prove unsatisfactory and costly in the modernization of existing structures.

continued on next page

GREENVILLE (ILL.) College's new gym is the best lighted in the country and the first to use radiant electric heat. Wiremold raceways carry power to lighting and heating units. Inset shows close-up of electric heater on laminated ceiling.

Code Comments

Baseboard Heating and Raceways

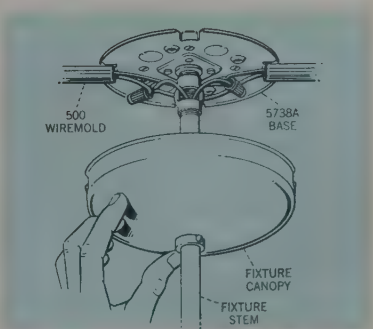
Q. *Can Plugmold be used above baseboard heating?*

A. Yes, subject to restrictions in Article 310, Section 310-4. This limits temperature on the conductor within the raceway to 140° F., as Plugmold is wired with type TW. In case of doubt, install a furring strip between the baseboard and the raceway.

Fixture Canopy for Fluorescents

Q. *Can back plates, both round and rectangular, be used as grounding plate when 5738F grounding box for fluorescent fixtures won't fit inside canopy?*

A. Yes. Article 410, Section 410-12 states, "In a completed installation, each outlet box shall be provided with a cover unless covered by means of a *fixture canopy* (italics ours), lampholder, receptacle, rosette, or similar device." Fixture canopy may be notched to accept the 500 raceway with a 657 Canopy Cutter.



WIREMOLD®

Advertisement

Editorial

Specifying "No Trouble"

Time and again, surface raceways get wiremen and engineers out of trouble—sometimes caused because someone "forgot" the wiring in a building plan.

Wiremold salesmen argue, "If it's good enough to get you out of trouble, why not specify it in the first place?"

Surface raceway systems by Wiremold have complete interconnectability with each other and with other wiring systems. They eliminate guesswork as to what's in the walls — and where. They can traverse any surface in any building; they are the easiest, least time-consuming wiring method anywhere — and, when painted, they blend with the decor.

That's enough to make Wiremold a part of the initial specs, isn't it?

Product of the Month

New UL rating increases usefulness of Wiremold 3000

New Underwriters' Laboratories ratings on Wiremold 3000 make it the only raceway on the market with these capacities. (See table.)

These new ratings permit as many as 14 No. 6 conductors to be installed, as compared to the 10 previously allowed.

So new are these ratings that the engineering data folder "Useful Literature" on this series is outdated in this respect. The ratings were under investigation when the folder went to press.

MAXIMUM NUMBER OF WIRES (OLD) — NO. 3000

Wire Size Awg	With Devices R, RH	With Devices T, TW, RW	Without Devices R, RH, T, TW, RW
14	10	10	30
12	10	10	25
10	10	10	13
8	8	10	12
6	6	8	10

MAXIMUM NUMBER OF WIRES (NEW) — NO. 3000

Wire Size Awg	With Devices R, RH, RU, T, TW	Without Devices R, RH	% Fill	Without Devices RU, T, TW	% Fill
14	10	44	29%	56	22%
12	10	40	32%	42	21%
10	10	20	27%	20	13%
8	10	14	31%	16	19%
6	10	10	35%	14	33%

Surface Systems Simplify School Wiring Problems

continued from preceding page

PLUGMOLD along the top of this laboratory bench provides plenty of outlets in high school science demonstration room. Multi-outlet strip avoids extension cords and dangling wires at the same time it provides a neat, economical installation.

Wiremold surface wiring systems are being used with increasing frequency to carry power and to feed lights and electric heating, and Plugmold multi-outlet systems to supply plenty of conveniently located outlets for the present and future.

In modernization work in particular, where there is a relatively short period during which the work can be done, surface systems have become an important factor. Wiremold systems reduce the amount of wall-breaking and subsequent redecoration needed and thus speed completion of the job.

WIREMOLD®

ELECTRONIC TEACHING devices use surface systems to connect console (right) to student booths. At Avon (Conn.) High School's new language laboratory Wiremold Pancake was used to feed the console and deliver power to student booths.

WIREMOLD surface systems were used to carry power for general and emergency lighting. The new Baldwinsville (N.Y.) school is of cinder block, laminated roof.

Advertisement

Quiz Corner

Q. *What fastening means should be used for attaching Plugmold to various surfaces?*

A. Nos. 1900, 2000, and 2200 take No. 6 flat head wood screws; Nos. 2100 and 3000, No. 8. On wood surfaces, use flat head wood screws or penny nails. On dry wall, use plastic shields with flat head wood screws or flat head sheet metal screws. On plaster, use plastic shields with flat head sheet metal screws. On brick, concrete, or cinder block, use masonry nail. On tile, use toggle bolt.

Q. *How can you tie 500 Wiremold raceway into the end of an electric baseboard heating unit?*

A. Use the 5785 Combination Connector, making ½" KO in baseboard heating unit, if necessary.

Q. *How do you attach 200 Wiremold raceway to a rectangular sheet metal exit sign?*

A. Use the No. 5785 Combination Connector with a 289 Reducing Connector.

Q. *I need an extra deep switch and receptacle box with an open base. Is such a fitting available?*

A. Yes, through the use of the 5744 Cover with the 5751 Base.

Q. *When do I use the rigid outside coupling on 3000 Wiremold?*

A. This coupling, No. 3001B, is used for coupling two lengths of 3000 (end to end) where extra strength is required, such as between beams.

Q. *Do you have a tee and a flat elbow for 2200 Plugmold Baseboard?*

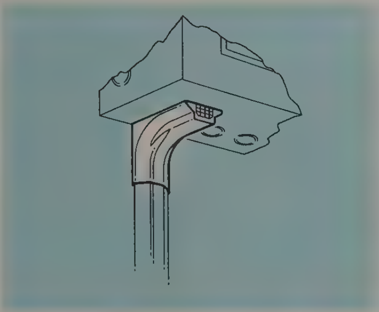
A. Yes, on special order.

Q. *Can you provide 2000 Plugmold with outlets on centers other than those shown in the catalog?*

A. Yes, as long as the spacings are in multiples of 3 inches. Exception: the 20GA series where the minimum spacing is 12" on centers.

Q. *How do I get from panel box on wall to 2600 on floor?*

A. Through the use of the 2186 Adjustable Offset Connector. This fitting is designed for use with either 2600 or 2100.



WIREMOLD ■ HARTFORD 10, CONN.
Gentlemen: Please send me checked items

NAME

COMPANY

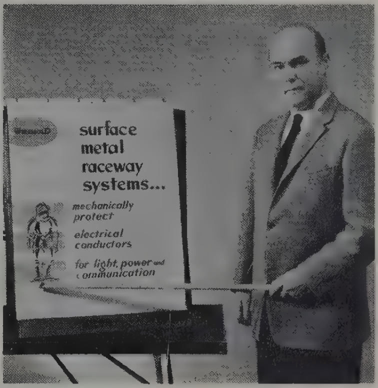
ADDRESS

☐ Wiring Guide (Catalog 22)
☐ Electric Ideas, March 1961
☐ Electric Ideas, April 1961
☐ Plugmold 3000 folder
☐ Progressive Architecture reprint

E1-5

Personnel Notes

Henning A. Thomsen, a member of Wiremold's engineering staff at Hartford, recently completed a two-week stint at the Washburne Trade School, Chicago, instructing approximately 450 first and second-year apprentices in the use of Wiremold products.


Wiremold
surface metal raceway systems...
mechanically protect
electrical conductors
for light, power and communication

Participating in NECA-IBEW apprentice training and other vocational school programs is considered an important part of the duties of our sales and engineering people.

Local sales representatives always are available to make Wiremold presentations when the assignments cover no more than a one or two-day session. For longer periods, arrangements can be made to have a home office representative on hand.

Assisting Tom in Chicago were Ambrose J. Massey, Chicago district sales manager, and John P. Leddin, sales representative.

Meetings Ahead

No meetings this month—but if you're on the move, why not visit us?

When your travels take you into the Hartford area, we would be happy to have you stop in at our home office and tour our facilities. We'd enjoy having you meet our key engineering and production people (you'd be surprised how much we learn from visitors!) and discuss items of mutual interest.

WIREMOLD®

Advertisement

Engineered Specials

Single box adapted for high and low voltage

PROBLEM:

To provide a single surface-mounted box with a barrier so that both low voltage and high voltage would be available at the same location. Because the use was for a hospital communications system, low-cost and neat appearance were prime requirements.

SOLUTION:

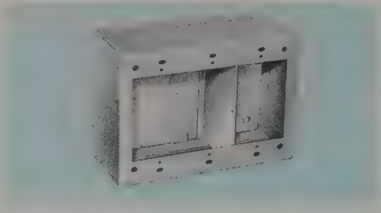
A 3-gang Wiremold box was adapted so that 110-v. power could be carried on one side of the barrier and low voltage on the other side. The entire system was designed to integrate with Wiremold 2100 for ease and neatness of installation.

DISCUSSION:

A Wiremold 5747 base was adapted to accept a Wiremold 5744 box. A metal barrier, not standard in the box, was welded in an off-center position.

By using existing tooling, KO's remained in their normal places for mating with the Plugmold run.

The system may be used to permit the patient to control a television or radio set from the bed. He can press a button to call the nurse and she can return the call from the floor station, rather than walk the corridor. The patient also can tie into the general communications of the hospital. Another use of the system is for a closed circuit TV set-up in isolation wards to permit the patient to see and talk with visitors in another part of the hospital.



The box itself may house many combinations of high and low voltage devices. For example, it may hold a light and a speaker, or four small indicator lamps and speaker, or push buttons and lamps.

The completeness of the Wiremold line of fittings often proves a distinct advantage in meeting unusual field problems. Because each raceway series is designed with all the necessary fittings, it is possible for the factory to work with contractors and engineers in meeting the practical problems encountered in planning wiring layouts.

Wiremold engineers gladly accept the challenge of adapting standard Wiremold products for specially engineered applications.

USEFUL LITERATURE

Check coupon on preceding page for copies of listed items.

Plugmold 3000 Data

Complete engineering data for Plugmold 3000 is contained in a recently-released 4-page folder. (A just-issued UL approval increases capacities shown. See "Product of the Month," second page.)

WORTH READING

Check coupon on preceding page for copies of listed items.

Multioutlet Electrical Systems by Walter J. Douglas, P. E., Progressive Architecture, March 1961. A review of how multi-outlet systems help satisfy the demand for power flexibility.

Practical Tips

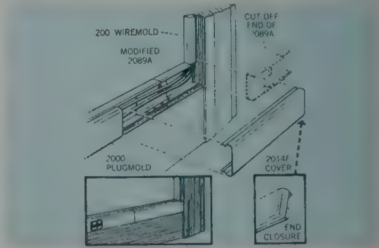
Fitting makes for simple, neat run around door

Running Plugmold 2000 around a door casing is no problem when a 2089A Side Reducing Connector is shortened for the job. Use of the fitting permits going around the obstruction with a neat, virtually unnoticeable run of Wiremold 200.

First, the fitting is cut so that the 200 can hug the trim. Then, couple the fitting to the 2000 base. Slide the 200 over the tongue and run around the door. Follow the same procedure on the other side. Use of 2014E Splice Cover with each of the modified fittings gives a beveled edge at each side of the door casing.

By this technique, the customer gets all the outlets he needs through the Plugmold, along with an unobtrusive run around any door casing. The one-piece raceway fits snugly against the casing and when painted to match, becomes part of the trim.

Installation tips such as this are to be found in the Wiremold Wiring Guide; check coupon on preceding page for your copy.



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HARTFORD 10, CONNECTICUT

All WIREMOLD products are sold through electrical distributors — your best source for all electrical products.

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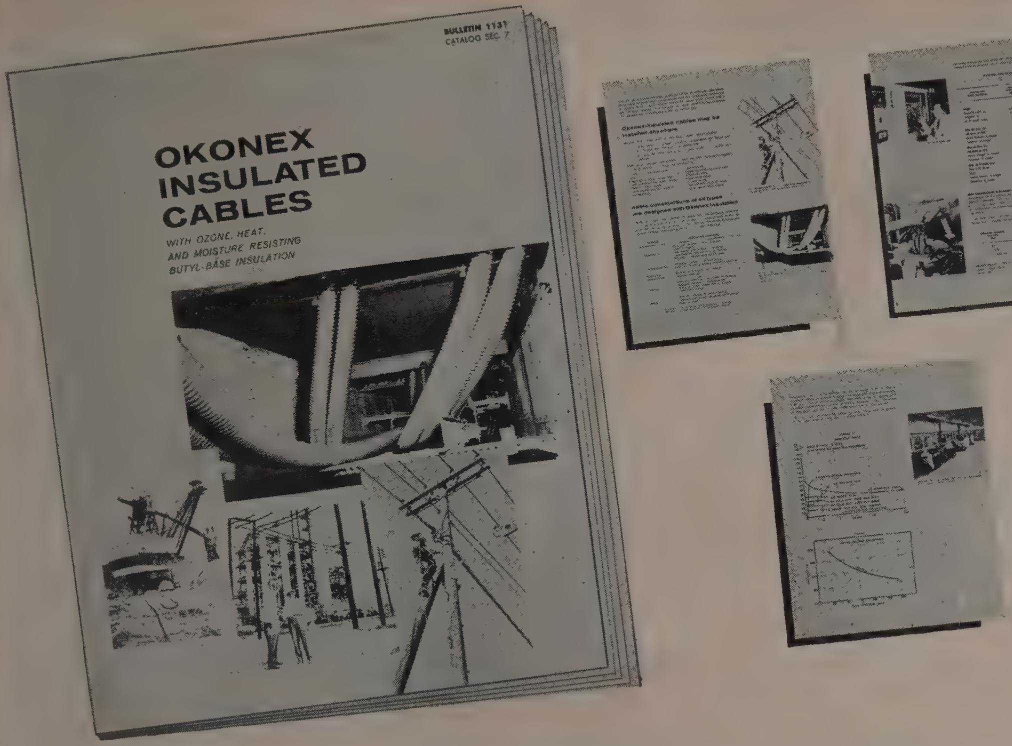
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CATALOG SEC. 7
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WITH OZONE, HEAT, AND MOISTURE RESISTING BUTYL-BASE INSULATION

NEW! Engineering data on OKONEX...

Okonite's **butyl base** high voltage cable insulation

Send for a copy of this handy reference which gives complete information on OKONEX, Okonite's service-proved butyl base rubber insulation. Designed for multi-purpose service up to 90C, OKONEX is extremely resistant to ozone, heat and moisture.

You'll learn how OKONEX insulated cables can help increase load capacities in existing systems . . . how OKONEX saves you time and money in the installation of new systems . . . why Okonite's self-imposed quality control and testing specifications are your assurance of dependability in critical circuits.

This booklet contains useful technical information on current carrying capacities, dimensional data, and features illustrative descriptions on many types of cable coverings—each designed for a specific environment. Such practical information should be helpful to you in the design and specification of efficient electrical systems.

To obtain your FREE copy of this new booklet, call your Okonite representative or mail the handy coupon today.

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Clock Systems	x	x	x	x		x	
Clock & Program Systems	x	x	x	x			
Paging Systems		x	x	x	x	x	
Intercommunication Systems	x	x	x	x	x	x	x
Language Laboratories	x						
Psychopathic Alarm Systems						x	
Nurses Call Systems						x	
In & Out Registers		x	x			x	
Annunciators		x	x	x		x	
Chimes	x	x	x	x	x	x	x
Bells	x	x	x	x	x	x	x
Buzzers	x	x	x	x	x	x	x
Horns	x	x	x	x	x	x	x
Push Buttons		x	x	x		x	x
Door Openers		x		x			x
Desk Push Buttons	x	x	x	x		x	x
Other Contact Devices	x	x	x	x	x	x	x

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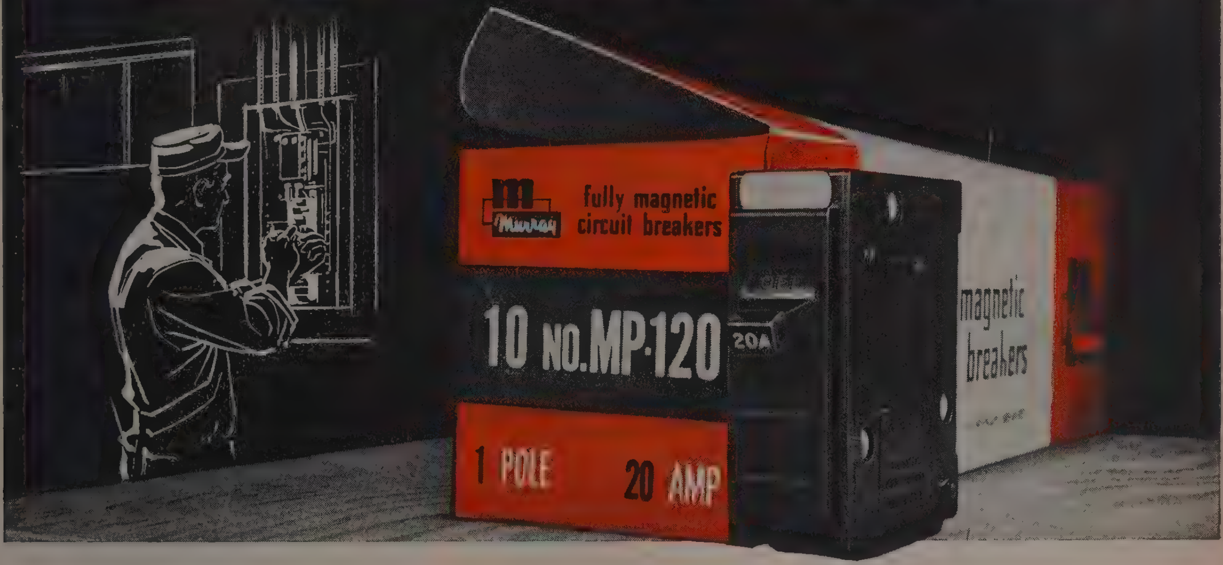
Murray "MP" Circuit Breakers



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You'll like working with "MP" breakers. *Fully magnetic* and unaffected by heat, these breakers never need derating, carry full rated load, never trip unnecessarily, can be installed anywhere it's most convenient for you or your customers.

Secondly, your customers will appreciate knowing that the breakers you install are *Guaranteed For Life.* It shows you're using the best, helps you get the business.

Extra Sales Aids For You! You get a special Guarantee Certificate to leave with each customer plus a special sticker for your own promotion to use on each load center. This will boost your prestige, bring extra business your way.

Here's How You Can Cash In On This Guaranteed For Life Program!

See your Murray wholesaler today for full information on this precedent-breaking promotion. Ask him also about the material he has available to help you sell builders and homeowners on Murray *Guaranteed For Life* "MP" circuit breakers. Or write Murray directly for complete details.

Backed By A Full Line Of Load Centers

Murray Manufacturing Corp., 1250 Atlantic Avenue, Brooklyn 16, N.Y.
Dept B-5

Gentlemen:

A circuit breaker that's *Guaranteed For Life!* I'm interested. As soon as possible, send me complete information on everything.

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My wholesaler is____________________

SWITCH NOW AND SAVE THE DIFFERENCE

Here's how changing from copper to Rome's aluminum TW building wire can improve your profit picture

The figures in the table tell the story. An installation using *aluminum instead of copper building wire usually costs less.* Savings on wire cost vary with size, as indicated in the table. Simply select the size and multiply the difference in cost by the amount of wire required. It follows, too, that the more times you use aluminum, the more you save. And don't forget, lightweight aluminum is easy to handle. For example, 1000 feet of No. 1 AWG copper Type TW weighs 115 lbs. more than aluminum wire of equivalent current-carrying capacity. Those are pounds you *don't* load, unload or carry. The savings in dollars are obvious. And you'll appreciate the ease of handling with the first installation—and every one that follows. For the full story on Rome Aluminum TW wire, contact your nearby Rome distributor or sales representative. Or, write to Rome Cable Division of Alcoa, Dept. 7-51, Rome, N. Y.

Rome Synthinol Type TW with aluminum conductor is available in a full range of sizes starting with #6 AWG. Underwriters' Laboratories approved. The insulation, a thermoplastic compound, is flame-resistant, oilproof, easy to pull, free-stripping and has extremely high dielectric strength.

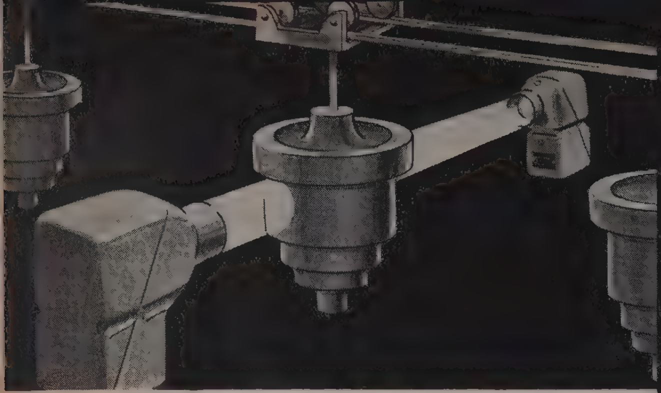
ALCOA
ROME CABLE
DIVISION

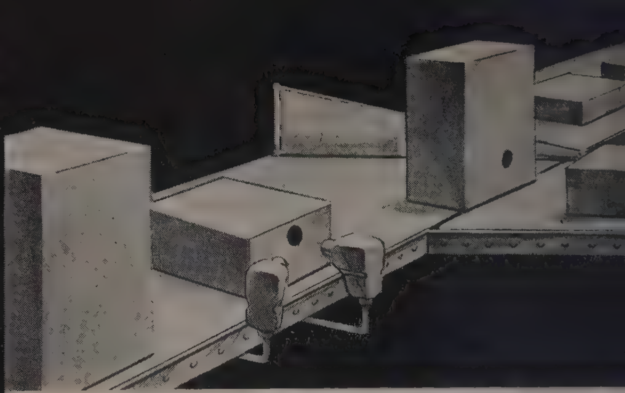
ROME SYNTHINOL BUILDING WIRE

TYPE TW – 600 VOLTS

Underwriters' Approved

COPPER			ALUMINUM			SAVINGS	
SIZE	NO. OF STRANDS	LIST PRICE	SIZE	NO. OF STRANDS	LIST PRICE	DOLLARS	PERCENTAGE (Approx.)
6	7	$ 67.30	4	7	$ 54.10	$ 13.20	20%
2	7	137.00	1/0	19	109.00	28.00	20%
4/0	19	406.00	300 MCM	19	311.00	95.00	23%
00 MCM	37	948.00	750 MCM	61	729.00	219.00	23%



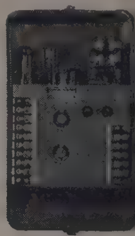


PRODUCTION COUNTING

Problem: Stepped-up production rate made it difficult to count units accurately with existing mechanical equipment.

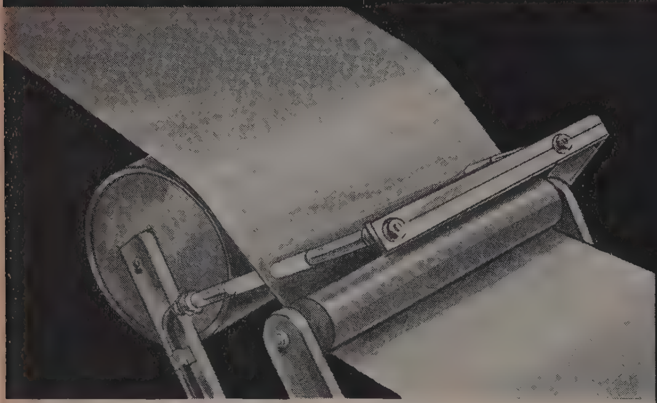
Solution: Plant Electrician installed two low-cost G-E photoelectric units connected to automatic counter. Even though production units come in bursts of over 150 per minute, this simple counting setup now tallies them swiftly and accurately.

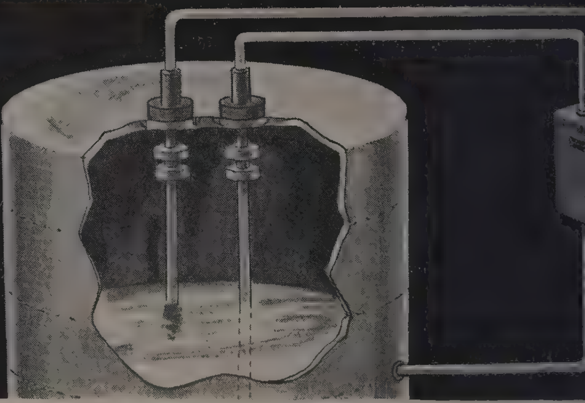
SORTING DISSIMILAR CARTONS



Problem: To automatically divert selected boxes from main conveyor to side conveyor.

Solution: Plant engineer suggested printing black circular marks on those boxes to be diverted. The absence of reflected light from the marked boxes trips the G-E photoelectric units and switches boxes to side conveyor. Unmarked boxes continue straight ahead on main conveyor.





DETECTING WEB BREAKS

Problem: Paper mill experienced excess losses caused by web breaks and decided to investigate automatic detection equipment.

Solution: At G-E Application Engineer's suggestion, plant installed photoelectric web-break detectors. These units detect breaks instantly. Light penetrates through break to scanning photoelectric relay which immediately stops machine.

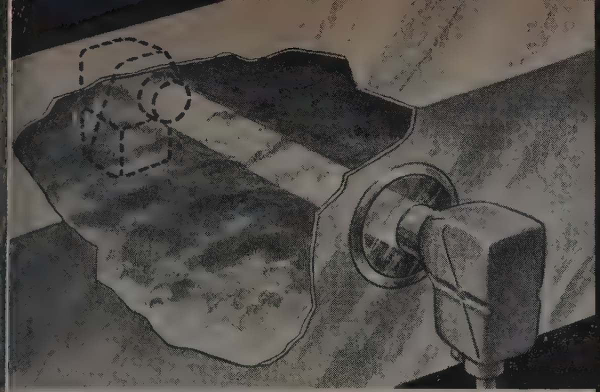
SENSING LIQUID LEVEL

Problem: Brewery planning to add 10 new vats wanted to equip them with most economical liquid level control.

Solution: At the Plant Electrician's suggestion, General Electric resistance-sensitive relays with stainless steel probes were installed on each vat. These standard devices have only one moving part, are easy to install, and require little maintenance.

A complete line of photoelectric and electronic devices for controlling, sorting, limiting,

1. **Explosion-proof relay** is high-speed type in special enclosure for use in hazardous locations.
2. **Smoke density indicator** is designed for combustion control or alarm: range is adjustable from 3—100%.
3. **High-speed relay** offers .001-second sensitivity. It also includes time delay and interlock.
4. **Long-distance relay** will operate up to 2500 feet without adverse effects from ambient light.
5. **Voltage-sensitive relay** operates on input signal voltage that ranges above or below pre-selected value.
6. **General-purpose relay** is low-cost, indoor-type photoelectric relay, flexible to operate, easy to adjust.



MEASURING BURNING EFFICIENCY

Problem: To determine that furnace was operating economically, and well within local smoke ordinances.

Solution: Plant Engineer installed G-E electronic smoke density indicator. In addition to performing corrective action, the indicator coupled with a strip chart recorder gives a day-by-day record of burning efficiency. It also satisfies local authorities that smoke is within prescribed limits.

AUTOMATIC CONVEYOR UNLOADING

Problem: Plant wanted to prevent reversing of loaded conveyor upon shut-down of hopper.

Solution: Plant Electrician wired simple electronic timer to hopper switch and to conveyor motor. When hopper closes, timer starts, counts off 45 seconds (long enough for conveyor to dump load completely), then stops conveyor automatically.

counting, and detecting applications

7. New high-speed relay is a low-cost unit for use with miniature or micro-miniature source and cell.
8. Transistorized relay features high reliability with miniature and micro-miniature source and cell.
9. Resistance sensitive relay operates on change in external resistance, ideal for liquid-level control.
10. Electronic timer is dial-set for given time; can be energized or de-energized before the timed interval.
11. Light sources and receivers are available in standard, miniature, and micro-miniature sizes.
12. Self-contained relay is low-cost, compact, tubeless photoelectric relay, ideal for limit-switch-type applications.

CONTROLS
FOR AUTOMATION

6 production problems SOLVED with General Electric electronic devices

These six production problems, and hundreds like them, are today readily solved with versatile General Electric electronic devices.

Applied with ingenuity, these devices now help plants sort, divert, detect, count, and perform other operations efficiently. And new uses turn up every day. For instance, the G-E resistance-sensitive relay is often used to control liquid level, but recently, it proved equally valuable as a thread-break detector!

Cash-in on such new uses of these versatile devices by contacting your authorized G-E Distributor early. He can solve many of your problems with electronic devices from stock. And his experience is invaluable on complex applications.

And for additional information on new ways to apply G-E electronic devices, return the coupon for your free copy of GEA-6822. General Electric Co. *Specialty Control Dept., Waynesboro, Va.*

Progress Is Our Most Important Product

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FREE CATALOG

General Electric Co., Section A793-05
Schenectady 5, New York

Please send me a copy of the G-E Electronic Devices catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

Name ______________________________
Company ______________________________
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City ____________________ State ____________

NEW! COMPACT 300 VOLT CONTROL RELAY Space-savingest relay ever! So reliable it is permanently enclosed.

NEW! D-C UNITIZED CONTACTORS. For steel or slate panels, front or back wiring. Six sizes 25 to 600 amperes.

New from Cutler-Hammer

New products, new ideas to help your business now

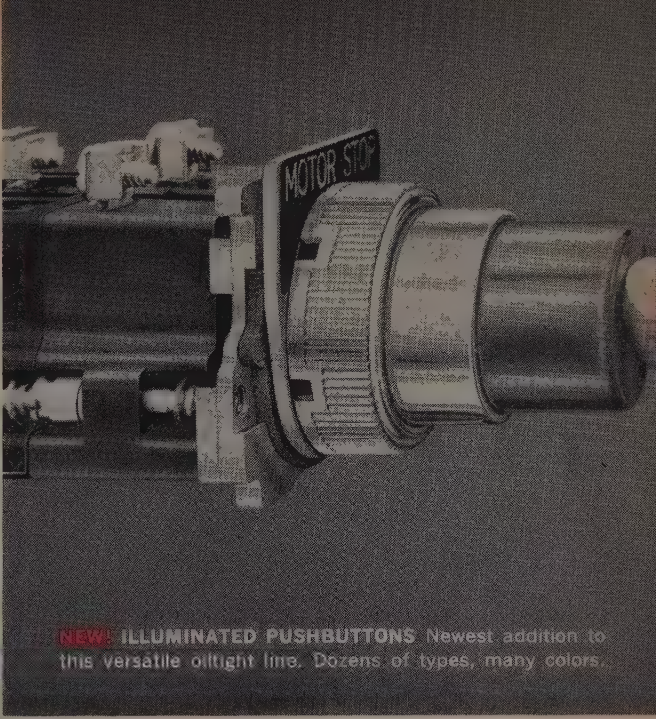
The air is charged with new ideas at Cutler-Hammer . . . ideas and products resulting from our new production facilities, new engineering talent, new research programs, and most important of all—*a new desire to serve you better in the sixties.* Evidence of this vitality and what it can mean to you are these eight typical new products.

You can expect more news from Cutler-Hammer around the calendar. Give your Cutler-Hammer sales office or distributor a call. They're all charged up too—anxious to tell you more about *what's new at Cutler-Hammer.* For descriptive literature on any of these products, write Cutler-Hammer or call your nearest Cutler-Hammer distributor.

NEW! SIZE 5 STARTER Available as starter or contactor. Really small . . . Open dimensions only 13" x 15 11/16" x 7½".

NEW! MOST VERSATILE FOOT SWITCH YET Choice of 4 operating variations by changing nylon cam position.

NEW! "UPSTAIRS-STYLED" SAFETYBREAKER Exclusive sandalwood finish. Simplest Non-Interchangeability by far!



NEW! ILLUMINATED PUSHBUTTONS Newest addition to this versatile oiltight line. Dozens of types, many colors.

WHAT'S NEW? ASK...

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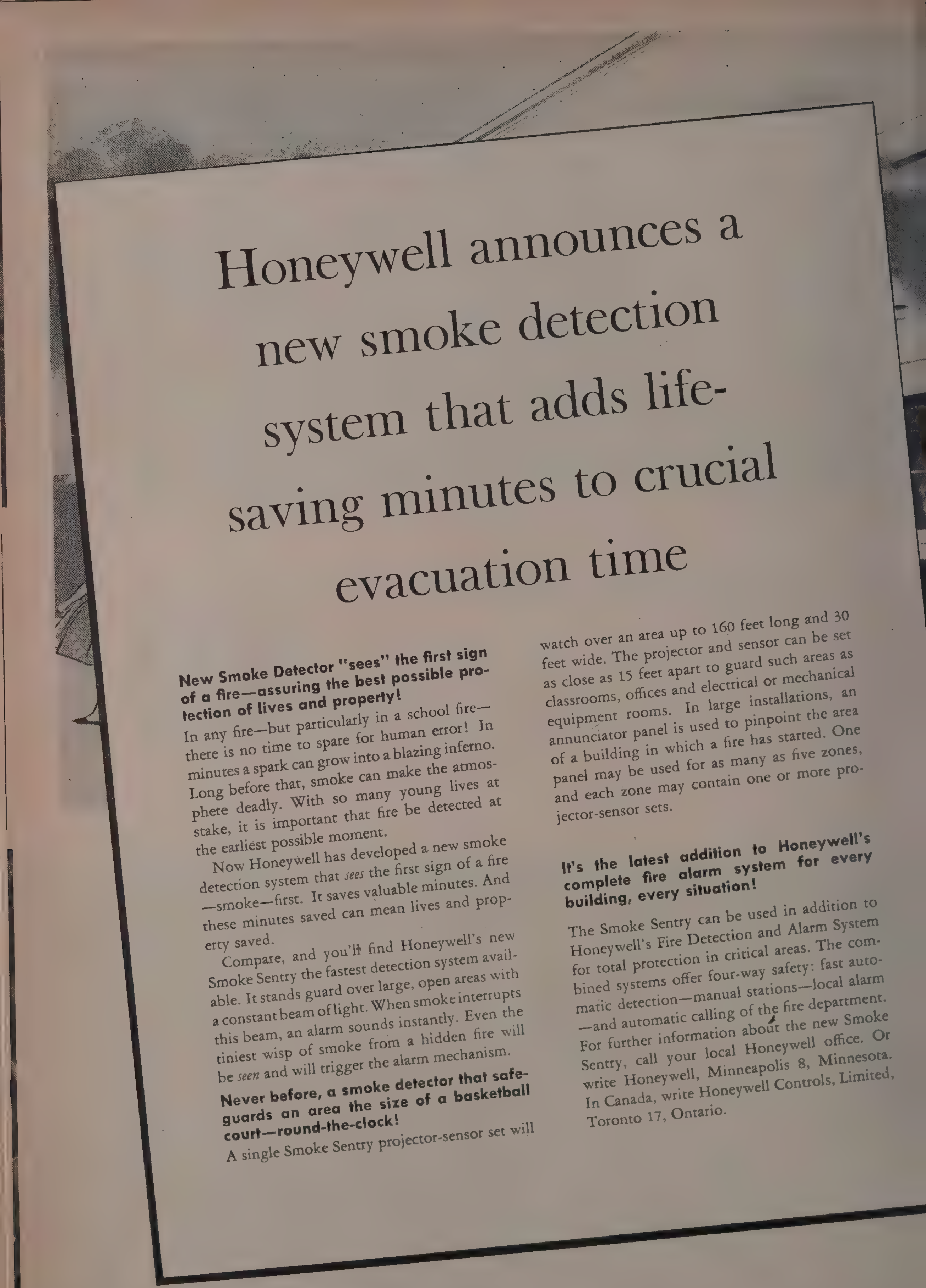
CONTROL

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

NEW! SPACE-SAVING 00 STARTER Takes 20% less space, costs 18% less than Size 0.

NEW! MOST RELIABLE LIMIT SWITCH EVER This oiltight switch outlasts others by far. Many operator options.



Honeywell announces a new smoke detection system that adds life-saving minutes to crucial evacuation time

New Smoke Detector "sees" the first sign of a fire—assuring the best possible protection of lives and property!

In any fire—but particularly in a school fire—there is no time to spare for human error! In minutes a spark can grow into a blazing inferno. Long before that, smoke can make the atmosphere deadly. With so many young lives at stake, it is important that fire be detected at the earliest possible moment.

Now Honeywell has developed a new smoke detection system that *sees* the first sign of a fire—smoke—first. It saves valuable minutes. And these minutes saved can mean lives and property saved.

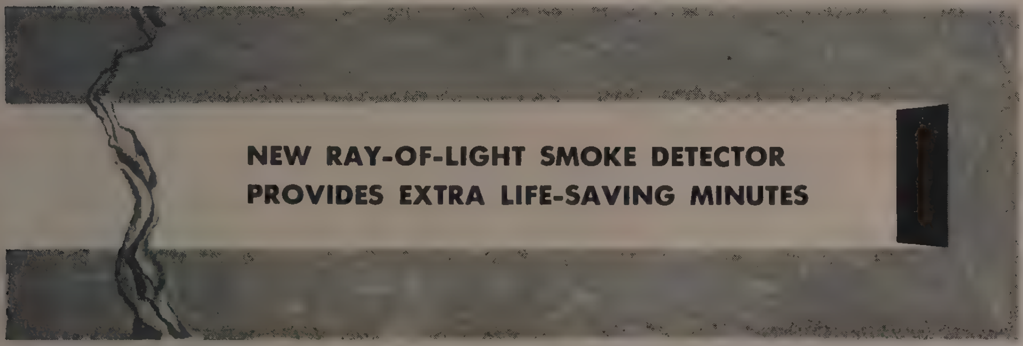
Compare, and you'll find Honeywell's new Smoke Sentry the fastest detection system available. It stands guard over large, open areas with a constant beam of light. When smoke interrupts this beam, an alarm sounds instantly. Even the tiniest wisp of smoke from a hidden fire will be *seen* and will trigger the alarm mechanism.

Never before, a smoke detector that safeguards an area the size of a basketball court—round-the-clock!

A single Smoke Sentry projector-sensor set will watch over an area up to 160 feet long and 30 feet wide. The projector and sensor can be set as close as 15 feet apart to guard such areas as classrooms, offices and electrical or mechanical equipment rooms. In large installations, an annunciator panel is used to pinpoint the area of a building in which a fire has started. One panel may be used for as many as five zones, and each zone may contain one or more projector-sensor sets.

It's the latest addition to Honeywell's complete fire alarm system for every building, every situation!

The Smoke Sentry can be used in addition to Honeywell's Fire Detection and Alarm System for total protection in critical areas. The combined systems offer four-way safety: fast automatic detection—manual stations—local alarm—and automatic calling of the fire department. For further information about the new Smoke Sentry, call your local Honeywell office. Or write Honeywell, Minneapolis 8, Minnesota. In Canada, write Honeywell Controls, Limited, Toronto 17, Ontario.



NEW RAY-OF-LIGHT SMOKE DETECTOR
PROVIDES EXTRA LIFE-SAVING MINUTES

Honeywell

First in Control

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Manufacturing in the United States, United Kingdom,
Canada, Netherlands, Germany, France, Japan.

all new...from

The greatest line of lighting ever offered the industry

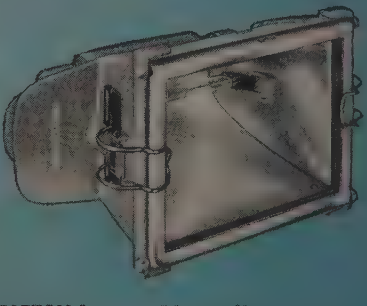
Each floodlight engineered for maximum lumen output ...Appleton Laboratory Engineered

Highest quality standards of construction throughout...yet competitively priced

APPLETON Intenso "Quartzlite 1500"

Big brother to the fabulous "Quartzlite 500," this super floodlight is the answer to maximum lumen output at economical cost. Every convenience built in . . . Appleton laboratory engineered throughout. Available in narrow, medium and wide beam spread. Pole top or crossarm mounting. Exclusive swing-over feature for relamping from rear. **Write for Bulletin QL 15-161.**

Never before in lighting history has there been such an offering as the new line of APPLETON floodlights. Each individual unit represents the latest in engineering . . . performance-proved in APPLETON's own laboratories. Not just one model, but *every* model incorporates the finest in design, the finest in construction, the greatest number of built in features and the greatest possible lighting efficiency. Before specifying floodlights for your next installation, check APPLETON.



APPLETON Intenso "Quartzlite 500"

The sensation of 1960! A beautiful, economical, high lumen output floodlight in a small package. The first of its kind to dissipate heat for proper operation of the iodine cycle lamp. Acclaimed and used, everywhere. **Write for Bulletin QL 560.**

APPLETON *electric company*

1701 Wellington Avenue, Chicago 13, Ill.

APPLETON

NEW Bulletins
Available NOW – Write!

APPLETON Intenso "Econoflood"

[illegible] beam spreads. Write for Bulletin EF 760.

Exclusive wick for special air and moisture filter action.

APPLETON Intenso "Generalflood"

A [illegible] convenience features. 14" floodlights for [illegible] floodlights for 750-1000 watt lamps. [illegible] narrow, medium, wide beam spreads. Write for Bulletin GF 960.

[illegible]

APPLETON Intenso "Sportoflood"

[illegible] NEMA beam spreads. Write for Bulletin SF 960

APPLETON Intenso "Mercflood"

[illegible] Write for Bulletin MF 761

The APPLETON *Intenso** Series

*The premium quality lighting line of the industry!

replace with

SYLVANIA SPIRAL ACCELERATORS

If you've an eye for quality and a need for economy in Spiral Accelerator replacement cathode ray tubes—specify Sylvania-5BGP-, 5BHP- for your high-precision 'scope equipment.

Sylvania Spiral Accelerators provide extraordinarily precise displays, exhibit exceptionally long life with resultant lower costs per hour of operation. Consider the reasons for such high quality. Guns, for example, are assembled on Sylvania-developed mounting jigs accurate to .001″. They're magnified 10 times actual size on optical comparators and critically inspected for spacings and dimensions. In addition, Sylvania Spiral Accelerators undergo tests for electrical characteristics, distortion, brightness. Spot size is microscopically measured at extreme corners of required minimum scan. Perpendicularity of horizontal and vertical scan lines is physically measured to meet 1.0° acceptance standards. Too, Sylvania-5BGP-, 5BHP- must meet severe cycled life tests.

Have a care! Replace with Sylvania Spiral Accelerators. Available in a wide range of phosphors. A phone call to your Sylvania Industrial Tube Distributor will bring swift delivery. For technical data write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 155, 1100 Main Street, Buffalo 9, N.Y.

Available from your Sylvania Industrial Tube Distributor

SYLVANIA

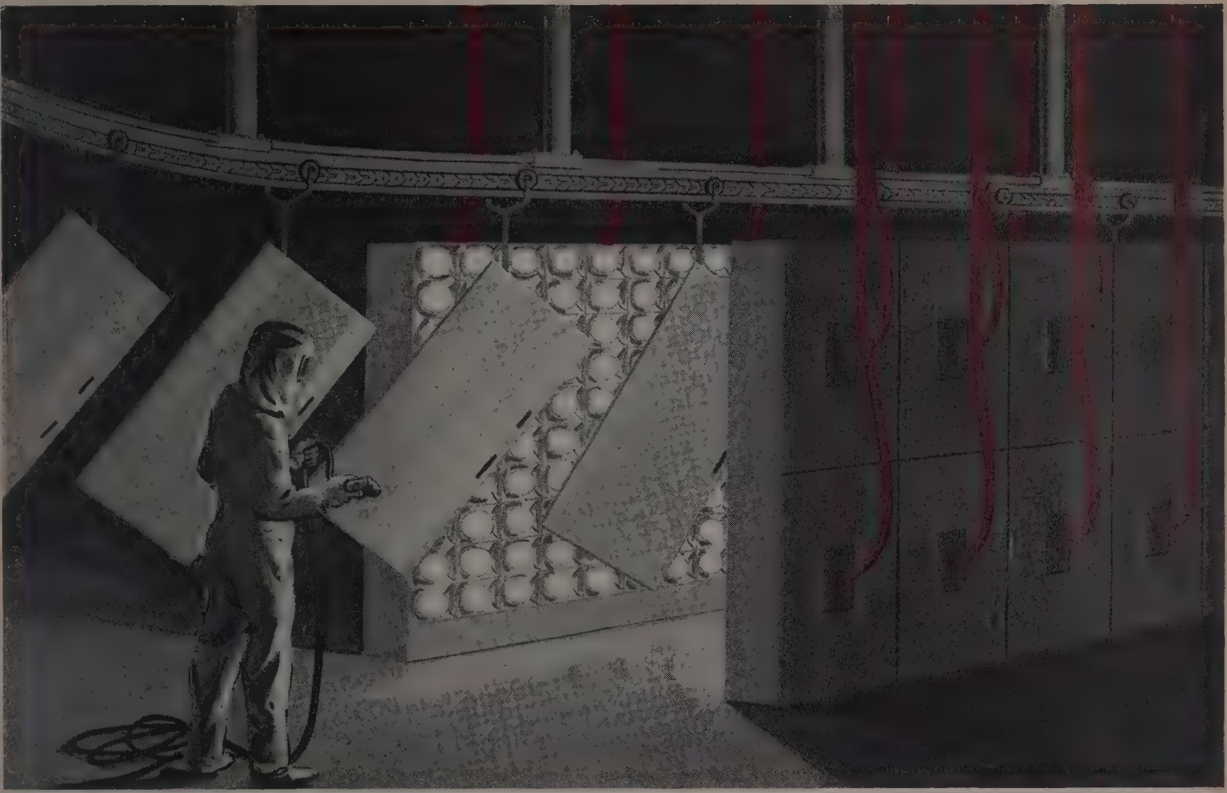
SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

SILICONE NEWS from Dow Corning

Use This Cable Plant-Wide



Silastic Insulation Withstands the Rigors of Heat, Cold and Weathering

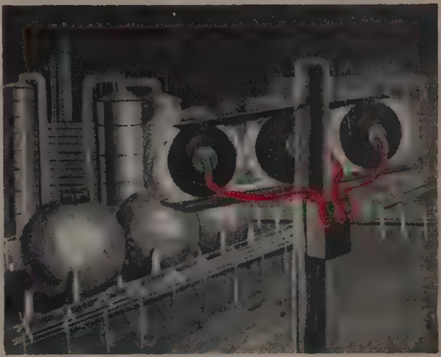
You can eliminate the extra expense of stocking many specialty wires and cables. How? By specifying Silastic®, the Dow Corning silicone rubber.

Silastic is more than a match for many of your plant's toughest service conditions. First of all, you can count on Silastic to give reliable service in or near ovens, boilers, fans, blowers and other "hot" applications where temperatures go up to 260 C. This cable covering resists the torture of high temperature aging, overloads or sudden power surges. Stays rubbery . . . it won't crack to allow electrical failure. And there's no brittleness even at —90 C . . . so you can flex Silastic insulated cable in bitter cold, too.

What's more, this versatile wire and cable insulation resists year 'round outdoor weathering . . . won't harden, crack or check. At a south Florida test station, Silastic samples showed no signs of weather deterioration after more than 9 years of continuous exposure.

Leading manufacturers now offer power cable, control cable, hookup wire, fixture wire and building wire with insulation of Silastic.

TYPICAL PROPERTIES OF SILASTIC FOR WIRE	
Temperature range, °F	—130 to 500
Insulation resistance, megohms/1000 ft.	1000 to 3000
Electric strength, volts/mil	300 to 500
Dielectric constant, 10^2 cycles per second, nominal	3.2



For new booklet on how to save with Silastic insulated wire and cable and list of suppliers, please address Dept. 2817.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

JOB-PROFIT TOOLING IDEAS

FROM GREENLEE

now even more help to speed your jobs, cut costs with the most complete and versatile line of hydraulic conduit benders on the market

WHATEVER THE

...THERE'S A

Save valuable time and materials, *control* *costs* by bending conduit right on the job with a Greenlee Bender. Wide choice of models for every bending need... ½″ through 6″ sizes steel and aluminum conduit and pipe. Make one-shot 90° bends . . . offsets . . . concentric bends... large sweeps... thin-wall bends. With the addition of the new No. 777 segment bender (left) for 1¼″ thru 4″ conduit, Greenlee offers you the widest selection by far, *all from a single source!*

No. 777 . . . lightest, most powerful 4″ Segment Bender. Only 65 lb (exclusive of shoes) Makes segment bends 1¼″ thru 4″ conduit. Perfect for tight kicks—bends 14″ from end of 4″ pipe.

One-shot 90° bending with Greenlee No. 777 Bender. An *exclusive* advantage. Adapts to one-shot 90° bending of ½″ thru 2″ conduit simply with addition of a few optional parts.

Thin-wall bending with Gre lee No. 777 bender. An *exclu* advantage. With quickly moun attachment the No. 777 bende economically converted to b thin-wall conduit ¾″ thru 2

For ½″ thru 4″ Conduit . . . Greenlee No. 884 bender makes fast 90° bends in one shot . . . steel and aluminum conduit. Lightweight, one-man operated with hand or power pump.

Offsets in seconds with Greenlee No. 888 Multipurpose Bender . . . A fast, extra-versatile bender for quickly making offsets in ½″ thru 2″ conduit . . . with one setting, one shot. Offsets always in perfect alignment—no doglegs! Also makes 90° bends, close to the end of conduit. Fast operation with hand or power pump.

BENDING JOB
GREENLEE TO DO IT!

For ½″ thru 3″ conduit . . . Greenlee No. 883 bender makes up to 90° bends with one shot in steel and aluminum conduit. Lightweight, portable. One-man operated with hand or power pump. Attachments available for thin-wall bending.

For ½″ thru 2″ conduit . . . Greenlee No. 880-M2 lightweight bender makes up to 90° bends with one shot in steel and aluminum conduit. Fast one-man operation with hand or power pump. Attachments available for thin-wall bending.

For 1¼″ thru 6″ conduit . . . Greenlee No. 785-BE power bender is equipped with 90° bending shoes for fast, easy operation. Can be used for one-shot or segment bending. Regularly equipped to bend sizes to 5″, with 6″ attachment optional.

GREENLEE TOOL CO., 1953 Columbia Avenue, Rockford, Illinois

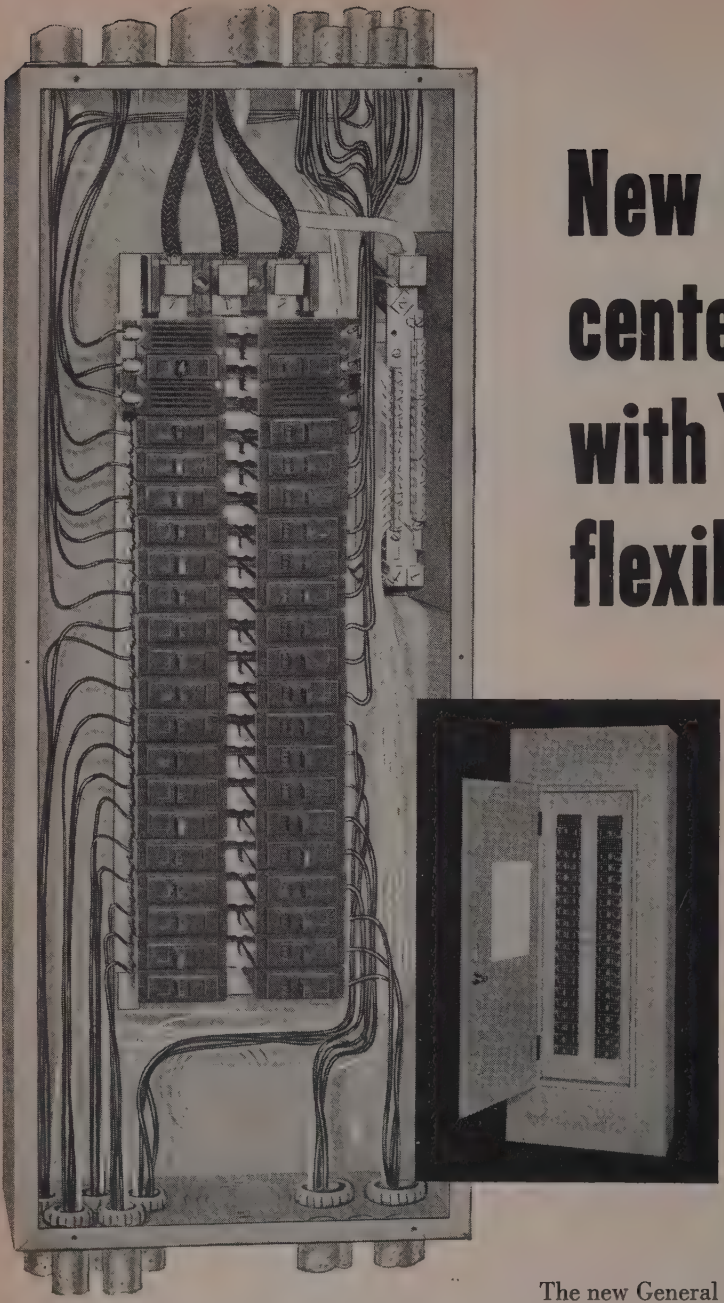
Ask your distributor for a demonstration, or write for literature.

TOOLS FOR CRAFTSMEN
GREENLEE ®

JOB PROFIT TOOLING

. . . cost control for contractors

New 3 phase load centers to 200 amps with "TWIN"* breaker flexibility



Cat. No. TRP42-420S 200 amperes . . . 42 circuits

*Trade Mark

- Full line of 3-phase, 4-wire load centers . . . 12 to 42 circuits . . . 125, 150 and 200 amperes.
- Sequence phased for maximum versatility with "TWIN," 1-, 2-, and 3-pole breakers . . . meets NEC non-interchangeability requirement for breakers . . . U/L listed.
- Snap-out interior . . . empty box mounts fast, leaves plenty of room to pull in wires . . . reversible box and interior . . . extra wide gutters.
- Tumbler type locking kit available . . . sealing loops . . . lugs accept copper or aluminum wire.

The new General Electric 3-phase load centers now provide the same time and cost saving features as the popular line of residential "TWIN" load centers. They're in stock now at your local G-E distributor, for either flush or surface mounting and in 12, 18, 24, 30 and 42 circuits to 200 amperes. 12 and 18 circuit models also available in raintight boxes.

For more information, write General Electric Company, Plainville, Conn. Ask for Bulletin GEA-7076.

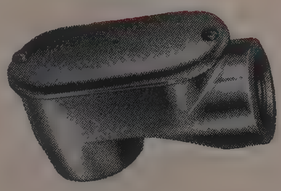
GENERAL ELECTRIC

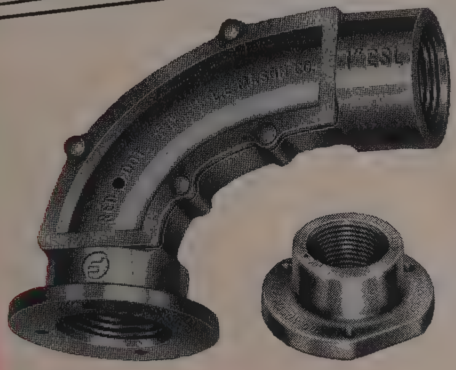
FROM EVERY ANGLE

RED ● DOT FITTINGS *offer*

VALUE
QUALITY
PROFIT

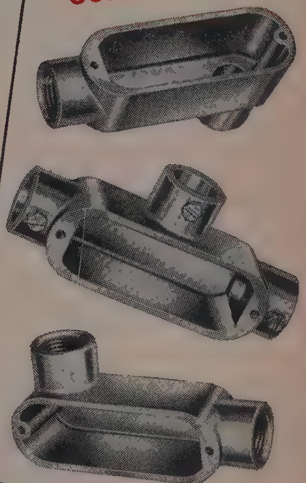
ENTRANCE ELLS



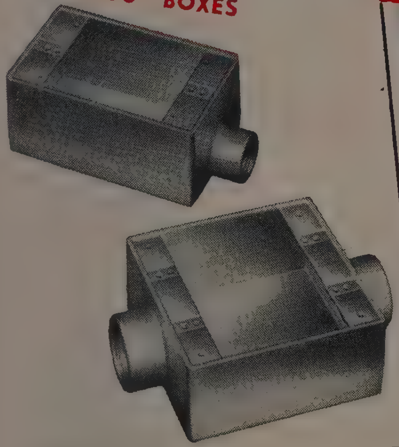


"ELECTRO - SERTS"

CONDUIT BODIES



"FS" BOXES



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EVERY WANTED FEATURE!

- Ultra-Hi Pressure Cast
- Aluminum, Copper Free Alloy
- Roomy, Unobstructed Interiors
- Flat Backed for Snug Fit
- Outstanding Design
- Satin Smooth, Inside & Out
- Adaptable for Every Use

COVERS & CORNER ELLS

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RED ● DOT EXCELS

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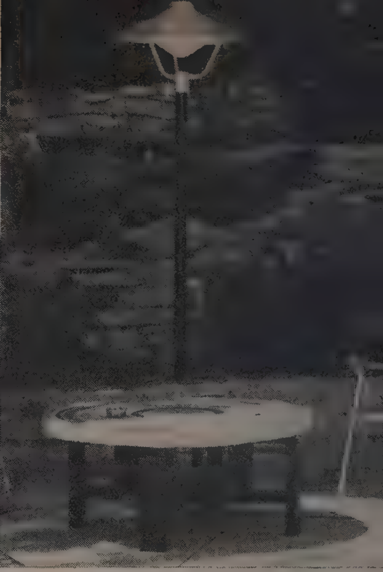
SERVING INDUSTRY *Mason* FOR 30 YEARS

L. E. Mason Co. BOSTON 36, MASSACHUSETTS

Type A LAWN-GLO Luminaire

Type B LAWN-GLO Luminaire



Type C LAWN-GLO Luminaire

L-M's exclusive "Lawn-Glo"(TM) luminaires are available in three styles, as shown above. Lawn-Glo luminaires offer hundreds of possible applications. Styled specially for locations where soft, low-level lighting is desired, in a high quality unit. Engineered reflector directs the light downward, does not waste it in glare. Most desirable for home driveways and patios; for smaller parks, playgrounds, swimming pools; for motels, gardens, terraces. Completely weatherproof design. Socket easily removed for lamp replacement. Concealed convenience outlet in base. Uses standard household incandescent lamps up to 150 watts. Choice of six decorator colors and brushed aluminum. Optional with redwood or black metal pole. Sold only through Authorized L-M Distributors.

L-M's Outdoor Lighting Line Offer

Units are excellent quality construction, engineered for efficiency and ease of applicati

Line Material, long a leader in quality outdoor lighting, offers modern, highly styled units to meet all outdoor lighting needs—industrial, commercial and residential.

Under a new distributor policy, L-M outdoor lighting equipment is available through electrical wholesalers—Authorized L-M Distributors. These distributors are reputable, competent firms who have been carefully selected by Line Material to assure you of service information and delivery.

Lighting for Every Outdoor Application

Line Material styled equipment is widely used in shopping centers, motels, hotels, swimming pools, trailer parks, parking lots, country clubs, public and private parks, fair grounds, amusement parks, churches, hospitals, marinas and yacht clubs, restaurants and drive-ins; and many other industrial and commercial locations where good lighting builds traffic, facilitates operations, and increases security.

Thousands of L-M lighting units have been installed at motels, parks, drive-in restaurants, and many industrial and residential locations.

OUR 50TH YEAR 1911 – 1961 LM

LINE MATERIAL®

McGRAW-EDISON

Outdoor

DISTRIBUTION TRANSFORMERS · RECLOSERS, SECTIONALIZERS AND OIL SWITCHES · FUSE CUTOUTS AND FUSE LINKS · LIGHTNING ARRESTERS · POWER SWITCHING EQUIPMENT
PACKAGED SUBSTATIONS · CAPACITORS · REGULATORS · OUTDOOR LIGHTING · LINE CONSTRUCTION MATERIALS · PORCELAIN INSULATORS · FIBRE PIPE & CONDUIT

M's EXCLUSIVE PTL luminaire, hand-
omely styled for parks, playgrounds,
otels, hotels, estates. Scientific
ptical system. Seven IES light pat-
erns to 10,000 lumens incandescent
r 250 watts mercury. Six colors and
rushed aluminum.

THE OUTSTANDING LIGHTING unit on the market today is L-M's exclusive "Styled Mercury" luminaire. 1000 or 700-watt lamps provide high level lighting for shopping centers, streets, large parking areas, for lighting and appearance.

L-M STYLED FLUORESCENT luminaires provide efficient even glare-free lighting. This entrance road and front parking area lighting were engineered by L-M Engineers especially for the Pennsylvania Railroad Truc-Train Terminal, Chicago.

Contemporary Styling, High Quality

Designs are styled by noted industrial designers. L-M offers wide variety for every need.

L-M offers many services through Authorized L-M Distributors:

- Complete Product Information
- Technical Information
- Application Engineering Service

Outstanding is L-M Lighting Application Engineering Service, available through Authorized L-M Distributors. Whatever your outdoor lighting problem, L-M engineers will help you solve it. L-M has more than 100 Field Engineers, who are backed by field service lighting specialists, and L-M's lighting engineering department.

Ask Your Distributor for Specifications or Mail Coupon

Get complete information on L-M Outdoor Lighting Equipment. Ask your electrical distributor; call the nearest L-M office; or mail the coupon below for information and the name of nearest Authorized L-M Distributor.

L-M OUTDOOR LIGHTING—Line Material advertising appears regularly in magazines reaching utilities, municipalities, architects, consulting engineers, managers and owners of shopping centers and public and private buildings, and a number of commercial establishments.

506-R

Industries
COMPANY
Lighting

McGRAW EDISON

Lighting Division, Line Material Industries, ECM-51
Milwaukee 1, Wisconsin
Please send information on the following L-M Outdoor Lighting Units:

☐ Also please send specifications

____ Lawn-Glo Lights ____ Post Top Light ____ Styled Mercury
____ Fluorescent Units

Name____________________
Company____________________
Address____________________
City____________________State____________________
Type of area to be lighted

SPECIFY Intermatic® TIME CONTROLS

...the best for every timing need!

RAPID REFERENCE CHART

SERIES	OPERATION	SWITCH	VOLTAGE	AMPS.	INTERMATIC QUALITY FEATURE
T 100	1 to 12 on-off per day	SPST DPST SPDT	125/250 volts	35	Standard ON-OFF switch.
T 170	1 to 12 on-off per day	SPST DPST SPDT	125/250 volts	35	Same as above, plus skips operation on selected days, automatically.
T 180	1 to 12 on-off per day	SPST SPDT	125/250 volts	35	Each on-off period independently adjustable from 5 to 60 minutes.
T 960	1 to 96 on-off per day	SPST SPDT	125/250 volts	20/15	Each on-off period in 15 minute units. Trippers permanently attached to dial.
C 8300	1 to 12 on-off per 12 minutes	SPST	125 volts	15	Timings from 10 seconds to 11 minute, 50 second periods.
T 500-R	1 to 12 on-off per day	SPST DPST	125/250 volts	55	Heavy duty standard ON-OFF switch. Up to 27,500 watts. Also available with "SKIPPER" feature.
T-1100	1 on -off operation per day	SPST	125 volts	15	Flush wall mounted standard ON-OFF switch to central circuits in house or store. (LAMP • LYTER)

WRITE FOR FREE CATALOG OF COMPLETE INTERMATIC LINE

THERE'S AN Intermatic FOR EVERY NEED!

Residential and Commercial Lighting Control • Air Conditioning Heating • Industrial Uses • Farm and Poultry Lighting • Signs Signal Bells, Buzzers, and Lights • Outdoor Installations Flush Mountings

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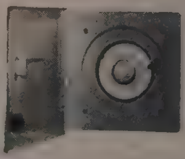
NEW! LAMP • LYTER

the light switch with an electric brain!

FOR HOME AND STORES

flush mounts, controls post lights, store lights, signs, other selected circuits.



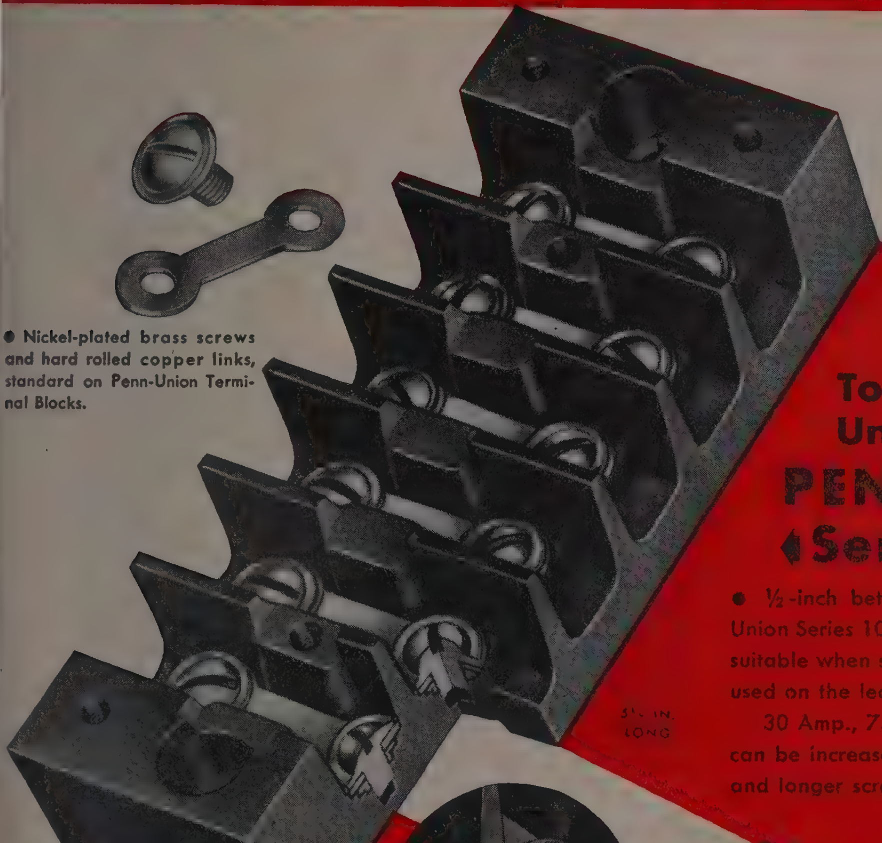
INTERNATIONAL REGISTER COMPANY

CHICAGO: 2624 West Washington Blvd. • NEW York: 41-14 24th St., Long Island City

Terminal Blocks

To Place More Units
Lengthwise— use
PENN-UNION
SERIES 1000

- Same wide slots as Series 6000 but narrow end barriers— designed for space economy *lengthwise.*



- Nickel-plated brass screws and hard rolled copper links, standard on Penn-Union Terminal Blocks.

To Place More Units *Sidewise*
PENN-UNION
◂Series 6000

- ½-inch between the barriers, same as Penn-Union Series 1000, but 16% narrower— especially suitable when soldered or solderless lugs are to be used on the lead wires.

30 Amp., 750 V. The short-time current ratings can be increased by using additional jumper bars and longer screws.

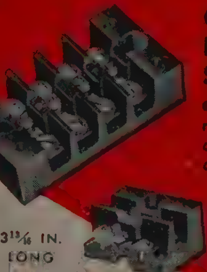
- Accurate alignment is assured by molding the brass inserts in the block, and tapping after molding.

COVERS

- Bakelite, hinged if desired. Holes are tapped at the corners of Penn-Union Series 6000 Blocks for attaching a Bakelite cover, which can be furnished with 4 screws . . . or with 2 hinges and 2 knurled-head captive fastening screws, as illustrated . . . or with spring clips for instant access.

Multiple Circuit Jumper Bars

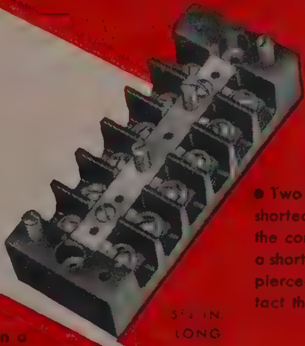
- To give any required branch circuits and tap-offs. Heavy rolled copper bar, in 12-circuit length, is cut to the circuits needed. At the left is shown one of the innumerable combinations that can be made.



Circuit Breaking Series 6000—CB

- Very convenient when it's necessary to open and close circuits easily — for instance when a complex circuit must be sectionalized to locate trouble or make an adjustment.

The circuit-closing screws have machined shoulders—so that when in the open position they can't be turned and closed by vibration.



Short Circuiting Series 6000—SC

- Two or more of the circuits can be shorted whenever desired. In place of the composition marking strip, there's a shorting strip of hard rolled copper, pierced to take shorting pins to contact the jumper bar.

Penn-Union makes a complete line of
Aluminum and Bronze
Electrical Connectors and Accessories
Sold by Leading Electrical Distributors

PENN-UNION ELECTRIC CORP.,
Erie, Pa.
Export Sales—Phillips Export Co.,
100 East 42nd St., New York 17, N. Y.

PENN-UNION

a good connection

NEW! Pilot-lighted directory on a new style G-E Master Selector Switch shows instantly which of 12 circuits are
Also has tiny locator light (permanently ON) that permits reading the directory and operating the switch in the dark.

From General Electric, to hel
...a more versatile, easie

Looking for a bright new idea to help you get profitable new business? Look no further than this page . . . G-E Remote-Control Wiring is for you!

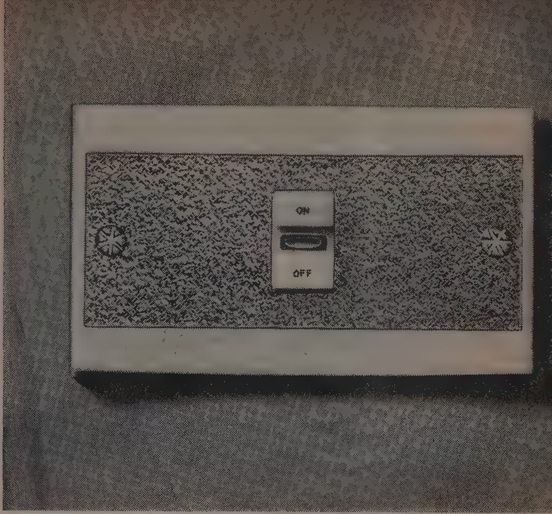
You offer step-saving convenience by providing several switches per light with this modern, low-voltage control system — at surprisingly low cost.

You dramatize this convenience in every room — with these handsome General Electric switches.
what a *variety* of switches you can use!

There's a new standard, push-button G-E Rem
Control wall switch, well marked for ON and OF
plus a *locking* type — plus a *trigger* type. And eac
available *non-lighted, locator*-lighted, or *pilot*-ligh

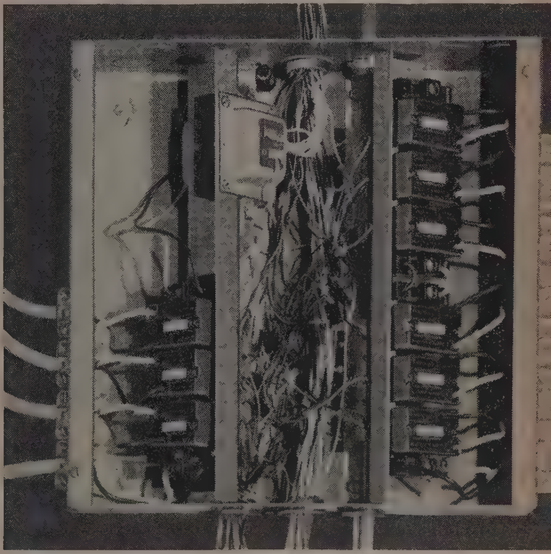
In addition, there's the impressive new lighted Ma

NEW! Switches that are easy to find in the dark. Now G-E Remote-Control wall switches are available with or without built-in locator lights.



NEW! Switches with built-in red pilot light. This new type of G-E Remote-Control switch is just the thing for controlling "hidden" lights.

NEW! Trigger and locking types. If your customers prefer an up-and-down "trigger" to the standard G-E Remote-Control push button, they can have it. You can suggest the locking type to prevent children from operating dangerous power tools



NEW! "Plug-in" relay box. Provides quiet operation, easier tracing and changing of circuits if needed. It impresses customers—simplifies your wiring. A bus bar connects relays to line voltage, automatically, as they're plugged in — to give you a neat, orderly installation.

MEDALLION HOME LIVE BETTER ELECTRICALLY

KEEP PACE ELECTRICALLY

ou get new business viring Remote-Control System!

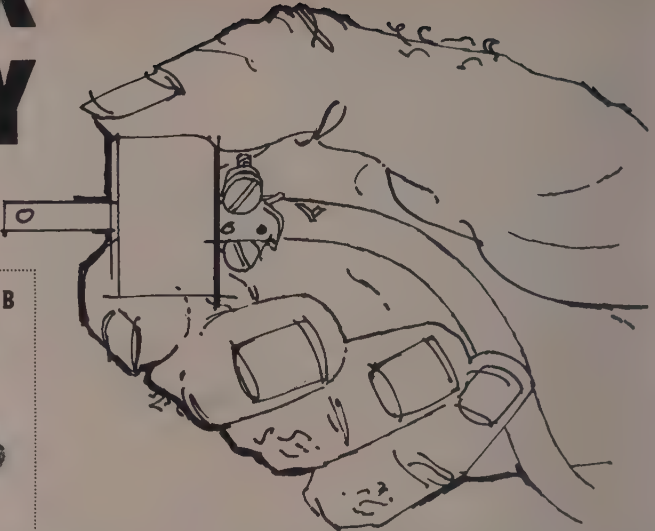
lector Switch — extension switches — an Inter-
angeable line.

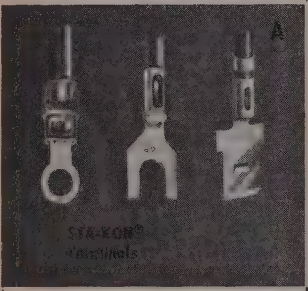
Ask your G-E distributor to show you this exciting
w General Electric Remote-Control Wiring line!
e for yourself the opportunities it offers to help you
t new business. General Electric Company, Wiring
evice Department, Providence 7, Rhode Island.

Progress Is Our Most Important Product

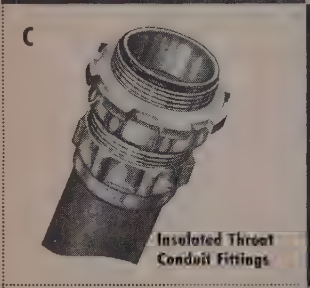
GENERAL ELECTRIC

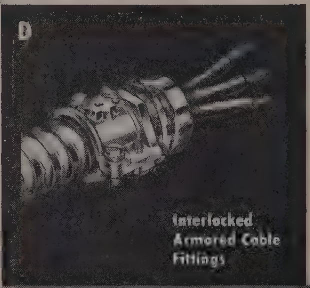
WHEREVER ELECTRICITY GOES . . .



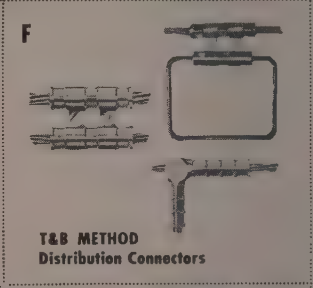

A
STA-KON® Terminals

B
COLOR-KEYED® Connectors

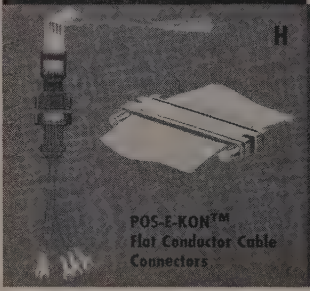

C
Insulated Throat Conduit Fittings


D
Interlocked Armored Cable Fittings

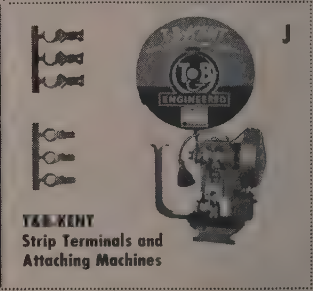
E
REDDY™ Tap
REDDY™ Lug


F
T&B METHOD Distribution Connectors

G
Watertight Floor Boxes


H
POS-E-KON™ Flat Conductor Cable Connectors

I
TY-RAP™ Cable Ties & Straps



J
T&B KENT Strip Terminals and Attaching Machines

For *every* electrical need—The Thomas & Betts Company offers a complete selection of connecting devices, terminals and fittings, designed for top performance at lowest installed cost. Illustrated are just a few of the many T&B-Engineered products that have proven themselves outstanding in the field. Wherever electricity goes . . . whatever the conductor . . . you're certain of complete reliability when you specify—and use—T&B Products. For further information, write to The Thomas & Betts Co., Incorporated, Elizabeth 1, New Jersey.
In Canada: Thomas & Betts Ltd., Montreal, Quebec.

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B—BULLETIN CKP1
C—BULLETIN #85
D—BULLETIN F5-47
E—BULLETIN #86
F—BULLETIN U1-27
G—BULLETIN #85
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I—BULLETIN TR-3
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T&B ENGINEERED **THOMAS & BETTS**

SOLD COAST TO COAST EXCLUSIVELY BY YOUR T&B DISTRIBUTOR

completely FARADAY NEW FIRE ALARM SYSTEMS

As pioneers in the signaling industry, Faraday proudly announces their completely new Fire Alarm Systems, incorporating modern functional design.

New modular control panels—"pre-engineered" to provide greater flexibility to meet a wide variety of typical specifications—coded or non-coded. All factory inspected and Underwriters' Laboratories listed.

New call stations, attractively designed to blend with modern architectural decor, are simple to operate. Exclusive "Alerto-Glass"* feature silently commands attention.

There's a standard Faraday System to meet your individual requirement. For further information, send for the new Faraday bulletins or, if desired, a representative will gladly call.

FARADAY

Adrian, Michigan

*Trade-mark

Current news reports

WHAT'S HAPPENING IN ELECTRICAL SERVICES?

Highlights: A dry-type transformer that cuts installing time from 90 to 40 minutes. A motor control center that saves space. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity which are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

Lowest height, easiest access 5-kv metal-clad switchgear on the market. Just 72 inches high, you get eye-level instrumentation, shoulder-height accessibility of component parts. Other outstanding advantages: front-accessible current transformers; maximum compartmentation and dead-front construction for greater safety; full-panel metering; rapid, one-stroke breaker insertion. Choice of Allis-Chalmers stored energy or solenoid operated circuit breakers.

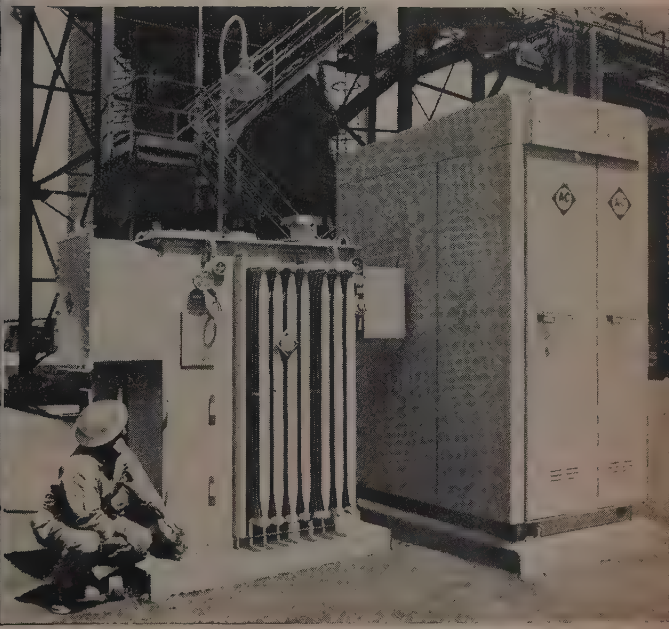
Here's proven accuracy in low-voltage switchgear with 3 independent elements available in a series trip device. You can get accurate settings with calibration scales below adjusting knobs on front of trip device. Minimum, maximum and intermediate time-delay band settings are field-adjustable for each pickup value for fine selectivity. Dead-front design with drawout interlock. Operator easily inserts and withdraws breaker. Simplified engineering reduces installation costs.

Curvacore, Super-Seal, Paxeal and Chlorextol are Allis-Chalmers trademarks.

Cut installing time in half with new, whisper-quiet dry-type transformers! Now 35% smaller, lighter, this new design eliminates common installation problems. Unique 3-piece case makes handling, wiring go like clockwork. You'll install them in 40 minutes instead of the usual 90 minutes. Every known factor in subduing noise has been incorporated . . . and exclusive *Curvacore* construction lowers exciting current, core losses. Requires *no* special insulating cable for hookup.

Control centers cut costs . . . You save space, simplify wiring and reduce inspection and maintenance expenses with new A-C low-voltage motor control centers. Plug-in terminal blocks and draw-out construction cut inspection and maintenance time by making it quick and easy to withdraw or remove control units. Pushbuttons and pilot lights on removable frames eliminate failures common with hinged wiring. Special connectors make it impossible for bus connections to loosen.

Acid drips, but open motor's efficiency never drops: This *Super-Seal* open motor replaced a TEFC unit driving a pump in a vanadium and uranium extracting process. Though constantly subjected to drippage of a sulphuric acid and organic phosphate mixture, it keeps right on running. Its *Poxeal* insulation defies corrosives, moisture and contaminants. Open design gives a service factor of 1.15 . . . provides reserve capacity to meet sudden overloads.



Lower first cost is just one of many advantages of this packaged unit substation. Simplified engineering, planning and purchasing reduce installation and maintenance costs. These A-C units provide reduced power losses, better regulation and flexibility for expansion. Factory-assembled, wired and tested to meet all standards. Transformer types available to fit your needs include oil-filled, *Chlorextol* liquid-filled, dry-type and sealed dry-type units.

ALLIS-CHALMERS A-1478

©1961 Volkswagen of America, Inc.

PAIR OF HARD WORKERS! Andersen Engineering likes the way their two rugged VW Panel Trucks "roll up their sleeves" and do a real day's work. Brawny engine mounted in the rear delivers remarkable traction. Mud, snow, ice are never a problem. Conduit is delivered right to the spot where the job's to be done. And there's never a parking problem with the nimble Volkswagen.

Chicago electrical contractor

Two VW Panels average 20 m.p.g. in start-and-stop city traffic

Mr. Al Andersen of the Andersen Engineering Co., Chicago, uses two VW's in his business—one as a rolling stock bin, the other as an all-around utility vehicle. He reports:

"We get real economy and real performance from our VW Panel Trucks. They're dependable in all weather. They drive and park well. The service is good. And their capacity is remarkable. We can store everything we need in our VW's—and still get to everything easily.

"As for economy, we get an average of 20 m.p.g. Pretty good for rugged start-and-stop city traffic. I figure our VW Panel Trucks cost us less than half what our other trucks do. I think they just can't be beat. I wish we'd bought ours long ago."

VOLKSWAGEN SURE CONDUIT! The Panel Truck has a cargo capacity of 1,830 pounds. Big double side doors and rear door make it easy to load and unload everything the Andersen outfit needs on the job—including long lengths of conduit. All told, there are 170 cubic feet of cargo space, 43 square feet of floor space. And all of it can be utilized and adapted for your specific needs.

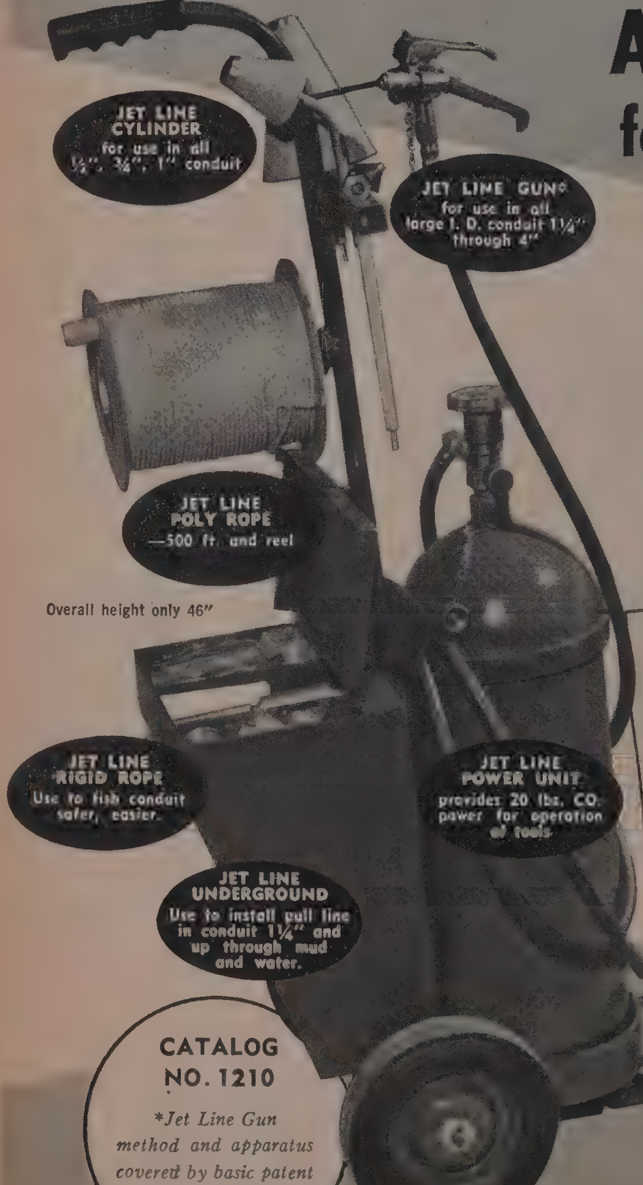
plugs Volkswagen economy

This sort of enthusiasm is typical. It explains why there are over 100,000 VW Truck owners in the U.S. today. Volkswagen is the advanced truck idea that's been proven on the road for the past 11 years.

Are you ready for a VW Truck? You are if you want a truck that costs less to buy, less to operate and less to service. The suggested retail price for the Volkswagen Panel Truck (East Coast Port of Entry) is $1,895 (West Coast, $2,015). To help you make the right decision, talk to your Authorized Volkswagen Dealer soon. Ask for a demonstration. And get your free copy of the 60-page illustrated booklet—"The Owner's Viewpoint." It documents with facts and figures VW Truck performance and owner experience in a wide variety of businesses. It shows what *you* can expect from a VW.

JET LINE® Jetmaster®

makes you A ONE-MAN GANG for all conduit wiring jobs


JET LINE CYLINDER for use in all ½", ¾", 1" conduit
JET LINE GUN® for use in all large I. D. conduit 1¼" through 4"
JET LINE POLY ROPE —500 ft. and reel
Overall height only 46"
JET LINE RIGID ROPE Use to fish conduit safer, easier.
JET LINE POWER UNIT provides 20 lbs. CO₂ power for operation of tools
JET LINE UNDERGROUND Use to install pull line in conduit 1¼" and up through mud and water.

Here's the all-new Jetmaster — combining the entire Jet Line Method* into one handy, compact, easily portable unit! On any wire pulling job, with Jetmaster you'll have all the Jet Line tools, accessories, and power you need — right at your fingertips. Jetmaster saves countless hours (and dollars), helps you pull wire quickly, easily, safely in any size, any type conduit from ½" through 4" I.D.

Jetmaster does the work of: Jet Line Gun, Jet Line Cylinder, Jet Line Underground, Rigid Rope. Contains all accessories necessary — poly rope and reel; line cones, packages, carriers; three pipe seal-offs — ½" thru 1", 1¼" thru 2", 2" thru 4".

Electrical contractors, utilities, and industries can save up to 70% of wire-pulling costs with Jetmaster — it pays for itself over and over again! (While the new Jetmaster combines the entire Jet Line Method, all individual Jet Line tools and kits may still be purchased separately. You choose the Jet Line Equipment that best meets your individual wire-pulling requirements.)

CATALOG NO. 1210

**Jet Line Gun method and apparatus covered by basic patent No. 2,930,584*

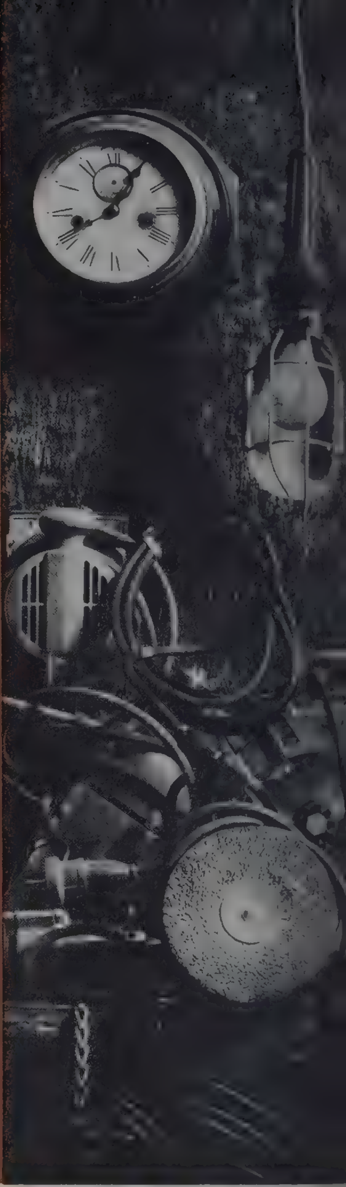
For complete information and prices, write your distributor or

JET LINE® PRODUCTS, INC.
305 Foster Ave., Charlotte 3, N. C.

5606

NNOUNCING A NEW WAY TO EVALUATE CABLES!

COPPER AND ALUMINUM CABLES . . . THE SPARK OF QUALITY IS KAISER WIRE EXPERIENCE! K/W



KAISER GRIZZLY® STANDS UP LONGEST IN EVERY OZONE TEST

Year after year, Kaiser Wire engineers check the relative ozone resistance of leading 5KV unshielded cables in "U" bend tests—with 40,000 V. potential between conductor and grounded plate. These tests prove Kaiser Grizzly Power Cable lasts at least twice as long as the best competitor . . . sixteen times longer than the test average. Kalzone® Insulation used on Grizzly cables surpasses IPCEA ozone resistance minimums by more than twenty times in tests.

K/W GRIZZLY
POWER CABLE
SPEC. 831
VALUE
270%
RATING

KAISER CONTROL CABLE PUTS MORE CIRCUITS INTO SMALL SPACE

The picture above shows an immediate value of Kaiser Laytex-Resin control cable—smaller diameter. The conduit at top, with Kaiser Laytex-Resin, has room for additional circuits. A comparable fill of competing cable does not. Perhaps even more important is the record of Kaiser control cable's famous Laytex insulation: service unmatched by any other insulation—thirty years of resistance to moisture, aging, and physical damage.

K/W
LAYTEX-RESIN
CONTROL CABLE
VALUE
767%
RATING

KAISER MASTER LAYTEX® COR
ELIMINATES 4 OUT OF 5 REPAIR

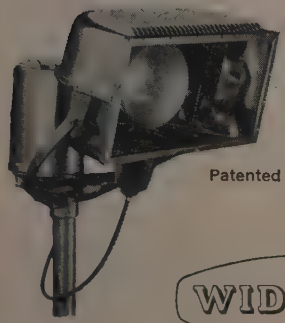
A single Kaiser Master Laytex po
able cord can last as long as
average cords. Reason: its paten
fibrous core and Laytex insulat
(natural rubber applied in origi
liquid form) give it a flexing-life u
twelve times as great as other porta
constructions. This eliminates as much as $23 in future tool connection labor — each time you connect a Kaiser Master Laytex cord. The Value Rating shows the service you receive per dollar you spend.

K/W
MASTER LA
PORTABLE C
VALUE
308
RATING

IN COPPER AND ALUMINUM CABLES . . . THE SPARK OF QUALITY IS KAISER WIRE EXPERIENCE!

K/

Can you imagine a thriftier way to light an explosion-hazard area?



Take a processing plant that sprawls across a large area. Add the danger of explosion that even the greatest precautions can't completely eliminate when you're processing natural gasoline. It adds up to a lighting problem about as tough as they come.

The solution usually involves a large number of low efficiency explosion-proof lighting fixtures, and costly explosion-proof circuits and controls. But not in the gasoline processing plant operated by the Sun Oil Company at Laverne, Oklahoma. As you can see in the picture above, the engineers used imagination in the lighting layout.

They simply placed 1000-watt mercury vapor Wide-Lites on 50-foot poles on the perimeter of the plant area, out of reach of dangerous fumes. The plant was lighted just as you'd light a football field. The lights are on a 480-volt system, reducing cost of transformers and permitting the use of smaller cable. And of course the installation provided the well-known advantages of color-corrected mercury vapor Wide-Lites—low power consumption; smooth, even lighting, and low maintenance costs.

Find out how Wide-Lites can help you make the most of your creative lighting abilities—send the coupon today!

WIDE-LITE

HIGH EFFICIENCY FLOODLIGHTS

OUTDOOR AREA LIGHTS • VAPOR TITE MODELS • INDOOR WORK LIGHTS • MOBILE WORKING LIGHTS • SPORTS LIGHTS PROTECTIVE LIGHTS

In Canada: Wide-Lite Division, Wakefield Lighting, Limited, London, Canada

WIDE-LITE CORPORATION
P. O. Box 191 • Houston 1, Texas **Dept. Q11**

Please send more information on Wide-Lites. No obligation, of course.

Name____________________

Company____________________

Address____________________

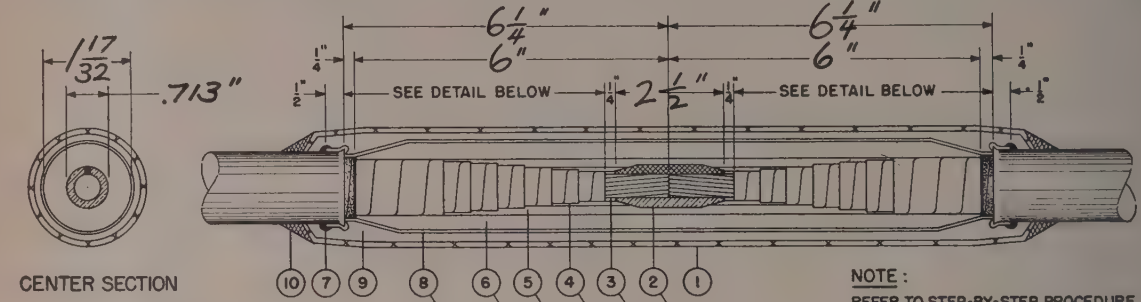
City__________Zone_____State_____

FOR John Doe
Electric Company
C.O. NO. 43967 ITEM 2
F.O. NO. 2-A-3695 ITEM 2
NO. OF UNITS 30
BY JEH DATE 4/5/61
APP. ACL DATE 4/5/61

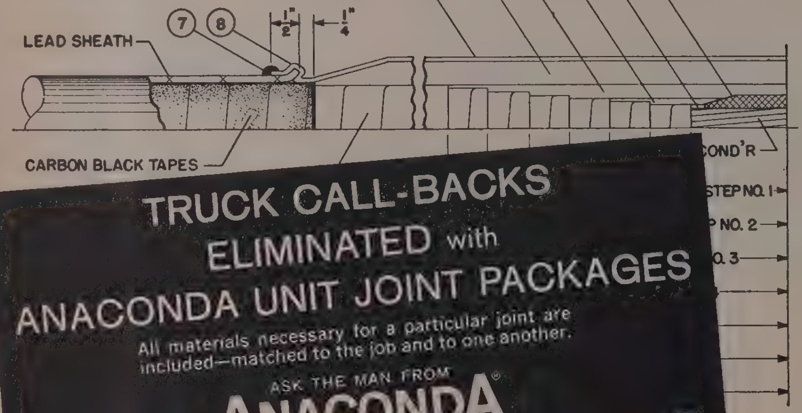
ANACONDA WIRE & CABLE CO.
ENGINEERING DEPARTMENT
ANACONDA from mine to consumer
HASTINGS-ON HUDSON, N.Y.

UNIT PACKAGE
JOINTING MATERIAL

STRAIGHT JOINT FOR TYPE CB
PAPER-LEAD CABLE
ONE CONDUCTOR, SIZE 4/0 AWG ~~MCM~~
CONDUCTOR SHAPE ROUND
INSULATION THICKNESS .175" ~~/64"~~
LEAD SHEATH THICKNESS .090" ~~/64"~~
RATED VOLTAGE 15 KV GRD. ~~UNGRD.~~



NOTE:
REFER TO STEP-BY-STEP PROCEDURE FOR DETAILS OF STANDARD JOINTING OPERATIONS.



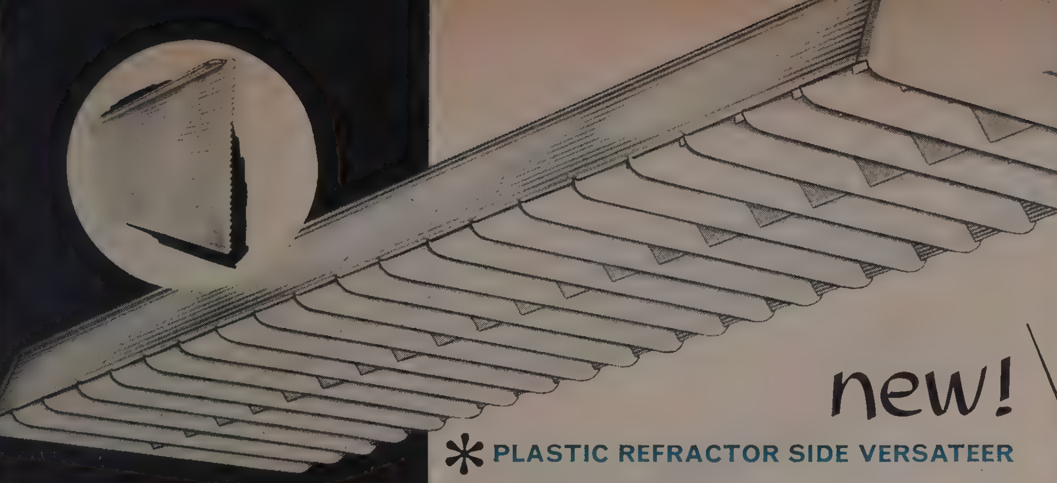
TRUCK CALL-BACKS
ELIMINATED with
ANACONDA UNIT JOINT PACKAGES
All materials necessary for a particular joint are included—matched to the job and to one another.
ASK THE MAN FROM
ANACONDA®
FOR UNIT JOINT PACKAGES

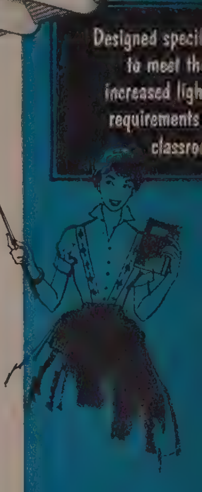
STEP NO.	LENGTH INCHES	TAPES TO REMOVE
7	—	—
6	—	—
5	6	CB TAPES
4	3 3/4	11
3	3	8
2	2 1/4	7
1	1 1/2	ALL

BILL OF MATERIAL CATALOG NO. 58111654-0-04

ITEM NO.	DESCRIPTION	QUANTITY PACKED
1	LEAD SLEEVE 2" IN. I.D. X 16 IN. LG. X 8/64 IN. WALL	1
2	SPLIT TINNED COPPER CONNECTOR, SIZE 4/0 AWG ~~MCM~~	1
3	V.C. TAPE, 3/16 IN. WIDE x 4 YD. PER ROLL	1 ROLLS
4	V.C. TAPE, 1/2 IN. WIDE x 4 YD. PER ROLL	1 ROLLS
5	V.C. TAPE, 3/4 IN. WIDE x 4 YD. PER ROLL	2 ROLLS
6	V.C. TAPE, 1 IN. WIDE x 4 YD. PER ROLL	9 ROLLS
7	BAR SOLDER	1/2 LB.
8	COPPER MESH TAPE, 3/4 IN. WIDE x 6 YD. PER ROLL	1 ROLLS
9	FILLING COMPOUND, NO. 150 SUPERSEAL	2 PINTS
10	WIPING SOLDER	2 LB.
11	FLUSHING COMPOUND, NO. 250 SUPERSEAL	1 PINTS
12	STEARINE FLUX	1 OZ.
13	PAPER PASTER	4
14	COTTON TAPE, 1 IN. WIDE x 3 YD. PER ROLL	1 ROLLS
15	COTTON YARN 1/8 OZ. PER ROLL	1 ROLLS
16	WASTE ENDS	2 OZ.
17	ALOXITE CLOTH	1-1FT. ROLL

OIL PACKED IN #300 SUPERSEAL





new!

✻ PLASTIC REFRACTOR SIDE VERSATEER

GREAT IDEA in modern lighting . . . the VERSATEER with refractor-lens sides. New, low-brightness plastic side panels smartly louvered give shadowless non-glare light upwards, outward and down. Sleek, modern appearance . . . maximum lighting efficiency . . . quality that competition can't touch at low budget prices.

E FINEST
SCHOOL LIGHTING
the
BENJAMIN
VERSATEER
w in TWO TYPES ✻

✻ METAL SIDE VERSATEER

HERE'S ANOTHER great economy unit of simplified all-steel construction including steel sides. Eliminates many costly maintenance problems. Sturdy, efficient, practical.

BOTH UNITS mount individually or in continuous row, suspended or surface. Special features include simplified finger-pressure louver latch. Both available in 35° x 25° and 45° x 45° shielding in 2 and 4 lamp construction. 4 and 8 foot rapid start, and 8 foot Slimline.

also ideal fo
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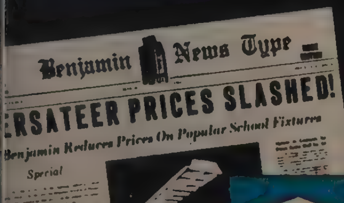
OFFICES
RESTAURAN
INSTITUTIO
other commercia
establishments



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ERSATEER PRICES SLASHED!
Benjamin Reduces Prices On Popular School Fixtures
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OMAS INDUSTRIES INC.
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East Broadway, Louisville 2, Kentucky
The World's Largest Single Source of Lighting

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BENJAMIN LIGHTING DIVISION, DEPT. BECM5
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☐ Please send catalog on Commercial Lighting

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FOR VOLTAGES OF 600 OR LESS

There's a *Safe and Dependable* BUSS Fuse or FUSETRON Fuse to fit the needs of every user...

...AND FUSES PROVIDE THE HIGHEST DEGREE OF PROTECTION AVAILABLE

A fuse is just as safe and accurate 20 years or longer after installation as it is on the day installed.

A fuse can provide high interrupting capacity at a very low cost to protect against today's high available fault currents. It can limit let-thru fault currents to exceptionally low values. A fuse can have long time-lag to prevent needless shut-downs.

Buss LOW-PEAK Fuses
200,000 amp. interrupting capacity . . . great current limitation . . . plus long time-lag.
Ask for Bulletin LPCS

FUSETRON dual-element Fuses
All purpose protective device for circuit, motor or equipment protection.
Ask for Bulletin FIS

Buss Hi-Cap Fuses
For loads above 600 and up to 6,000 amps. 200,000 amp. interrupting capacity, —plus current limitation.
Ask for Bulletin HCS

Buss LIMITRON Fuses
High interrupting capacity fuses with exceptional current limitation.
Ask for Bulletin HLS

BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

561

Buss Super-Lag Renewable Fuses

Lowest cost protection where periodic short-circuits are frequent.

Ask for Bulletin RCS

Buss One-Time Fuses

Low cost, safe protection for heating or lighting circuits where faults do not exceed 10,000 amp.

Ask for Bulletin NCS

Buss Clear Window Plug Fuses

One piece body and "safety" design guarantee protection.

Ask for Bulletin WUS

Buss FUSTAT Fuses

Fusetron fuses with Type "S" base resist overfuseing or tampering.

Ask for Bulletin SCPS

Fustats for motor protection.

Ask for Bulletin SMPS

FUSETRON dual-element Plug Fuses

Safely stop needless blows. Give full protection against short-circuits and overloads.

Ask for Bulletin TCPS

BUSS and FUSETRON Small Dimension Fuses and Fuseholders

For the protection of all types of electric and electronic devices.

Ask for Bulletin SFB

Get the Facts... write

Bussmann Mfg. Division, *McGraw-Edison* Co.
University at Jefferson, St. Louis 7, Mo.

From brawny, liquid-filled transformers outside of the Math and Physics Building, Field House, and Fine Arts Building, to whisper-quiet dry type units in the classrooms, laboratories, and dramatics hall, the University of Wichita uses Marcus transformers for dependable, trouble-free performance.

All Marcus transformers, both dry and liquid-filled score "excellent" in factory tests. Loss tests, hi-pot tests, impulse tests, and sound-level tests are passed with flying colors. For full power and guaranteed satisfaction, specify Marcus for *your* next transformer installation.

Representatives in Principal Cities

1500 KVA OIL FILLED TRANSFORMER

MARCUS TRANSFORMER CO., Inc.

RAHWAY, NEW JERSEY

A COMPLETE LINE OF DRY TYPE AND LIQUID-FILLED TRANSFORMERS THRU 5000 KVA

cable distribution rack, rectifiers, control panel and battery with rack. At other locations where shown, there shall be an automatic-dial-type telephone of the type designated by symbol. The system shall enable any station in the system to call and converse with any other station without the assistance of an operator. Lifting a handphone (or a receiver) on the calling station and dialing the desired number shall automatically ring the called station. The talking circuit is completed when the handphone (or receiver) is lifted at the called station. A busy signal shall be audible in the handphone (or receiver) of the calling station when the called station lines are preoccupied.

H. Apartment selective-ringing and common-talking system, vestibule to suites, suites to door-opener: In each tenant's suite, there shall be a telephone. A pushbutton shall be provided thereon to operate the door-opener at the main entrance. In the vestibule, there shall be a telephone and plate with pushbuttons and card-holders for every suite in the building. Pressing a pushbutton thereon will cause a bell or buzzer to ring in the corresponding suite telephone. Only one conversation is required at one time.

11.13 Equipment

Aa. Install at the two locations a handphone on cradle-type desk (or flush or surface wall mounting with handphone or with watchcase receiver and built-in transmitter) telephone having mounted thereon a pushbutton for calling the other telephone on the system. (Provide desk unit with 6-ft flexible cable, terminal-strip box and buzzer signal.)

Ba. Install in office where shown a master handphone on cradle desk (or flush or surface wall mounting with handphone or with watchcase receiver and built-in transmitter) telephone having mounted thereon ... pushbuttons (or selector switch with ... points) to call all outlying stations. At all other locations, install the type of telephone indicated by symbol, having mounted thereon one pushbutton (or selector switch with one point) to call master station. (Provide desk unit with 6-ft flexible cable, terminal-strip box and buzzer-signal.)

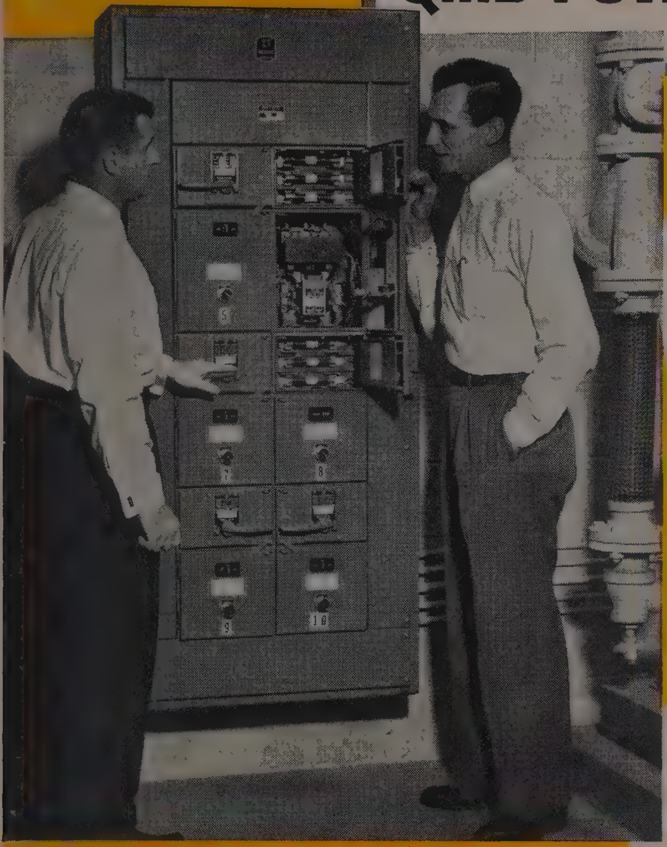
Bb. Install in or near power supply a retardation coil and connect to telephone system.

Ca. Install in office where shown a master telephone with handset mounted on a signal control board,

[Continued on page 208]

**SPACE–
TIME–
MONEY––**

Save All Three with Square D
QMB POWER PANELBOARDS



MOTOR STARTERS AND BREAKERS OR SWITCHES COMBINED IN ONE SPACE-SAVING PANELBOARD!

FACTORY-WIRED AND ASSEMBLED OR ENCLOSURES AND COMPONENTS AVAILABLE FROM YOUR SQUARE D DISTRIBUTOR!

BREAKER AND SWITCH UNITS ARE EXCLUSIVE PLUG-IN CONSTRUCTION. INSTALLED OR REARRANGED IN MINUTES!

If the above installation had been made the old way—with trough, and ganging separate switches and starters—it would have taken at least six feet of wall space instead of 30 inches, and four times the installation time.

After this panelboard is installed, Square D's exclusive *PLUG-IN* design permits circuit changes without costly down time. For extra safety, plug-in units are mounted directly above starters, permitting interlocking. No starter or disconnect door can be opened when switch is "ON."

QMB panelboards accommodate reversing or non-reversing starters, sizes 0 through 4; plug-in circuit breakers through 225 amperes; plug-in switches through 200 amperes (bolted through 600 amperes).

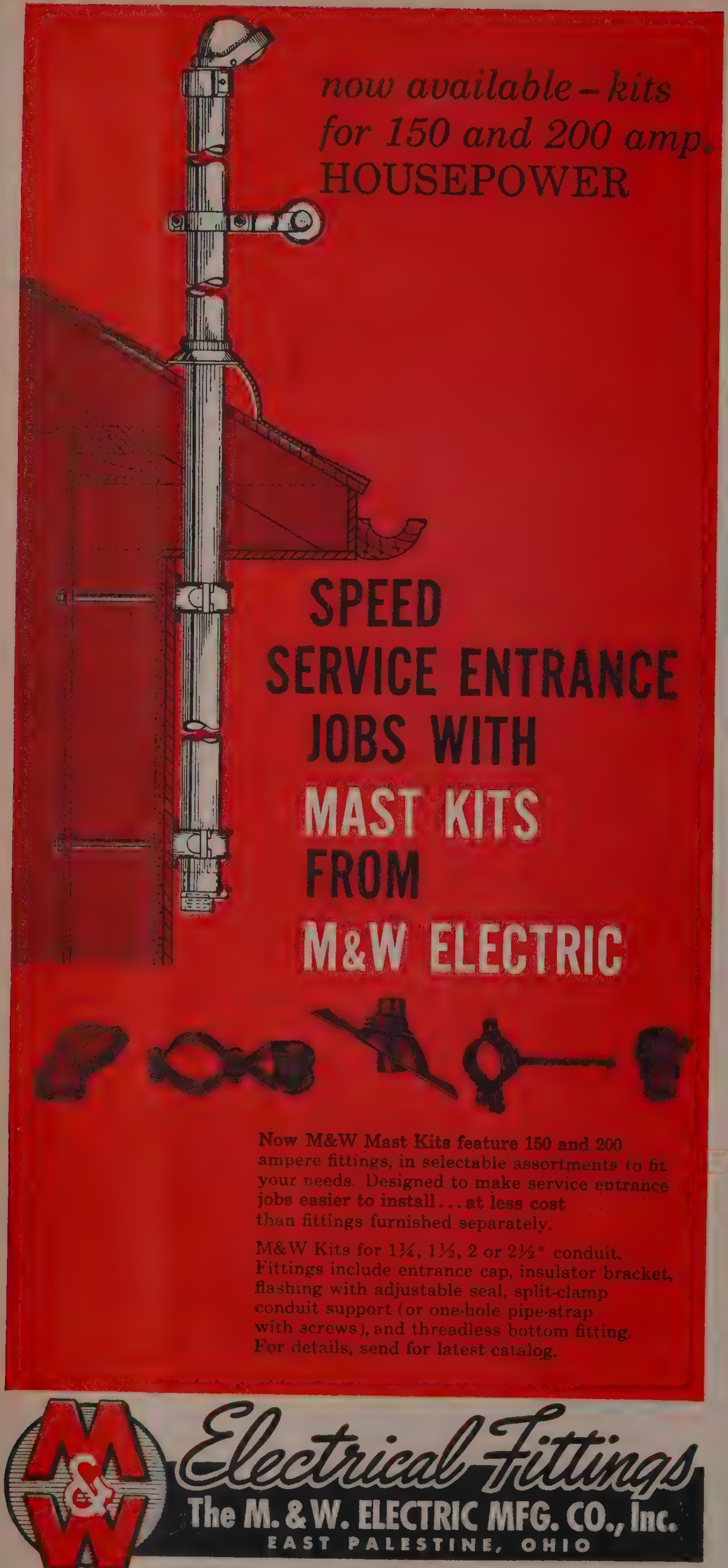
Twin Unit (above)
available 15-100 amperes
Single Unit available 125-225 amperes

Exclusive Breaker Unit Advantages:
Plug-in construction • Each unit in individual steel enclosure with dead-front construction • Combine switch and breaker units in same panelboard, if desired

Write for the complete story—Square D Company, Mercer Road, Lexington, Kentucky

SQUARE D COMPANY

wherever electricity is distributed and controlled


now available – kits for 150 and 200 amp. HOUSEPOWER

SPEED SERVICE ENTRANCE JOBS WITH MAST KITS FROM M&W ELECTRIC

Now M&W Mast Kits feature 150 and 200 ampere fittings, in selectable assortments to fit your needs. Designed to make service entrance jobs easier to install . . . at less cost than fittings furnished separately.

M&W Kits for 1¼, 1½, 2 or 2½" conduit. Fittings include entrance cap, insulator bracket, flashing with adjustable seal, split-clamp conduit support (or one-hole pipe-strap with screws), and threadless bottom fitting. For details, send for latest catalog.

M&W Electrical Fittings
The M. & W. ELECTRIC MFG. CO., Inc.
EAST PALESTINE, OHIO

flush or surface wall mounting, having the required number of pushbuttons and associated cardholders for every outlying telephone and other audible signals used in the program system. Adjacent to each pushbutton there shall be a set of openings each one representing a program circuit. A complete set of plugs shall be furnished, made to fit in these openings, and permitting internal connections from one program circuit to another, by means of horizontal circuit bars and vertical program circuit bars. A buzzer with cutoff switch shall be provided on this unit. At all outlying points, install the type of telephone indicated (cradle desk, flush or surface mounted with handphone or with watchcase receiver and built-in transmitter) by symbol without signal. Where cradle desk telephones are shown, provide same with 6-ft flexible cable, terminal-strip box and associated buzzer signal.

Da. Install at each location where shown a handphone on cradle-type desk (or flush or surface wall mounting with handphone or with watchcase receiver and built-in transmitter) telephone having mounted thereon . . . pushbuttons (or selector switch with . . . points) to call any other telephone in the system. (Provide desk unit with 6-ft flexible cable, terminal-strip box and buzzer signal; others with bell signal.)

Db. (Same as paragraph Bb.)

Ea. Install at each location where shown, a handphone on cradle-type desk (or flush or surface wall mounting with handphone) telephone having mounted thereon . . . locking pushbuttons (or reset selector switch with points) to call any other telephone in the system. (Provide desk unit with 6-ft flexible cable, terminal-strip box and buzzer signal; other bell signal.)

Fa. Install at each location where shown a handphone on cradle-type desk (or flush or surface mounting with handphone or with watchcase receiver and built-in transmitter) telephone. (Provide desk unit with 6-ft flexible cable, terminal-strip box and buzzer signal; other with bell signal.)

Fb. Install in telephone switchboard room a free-standing (or turret or desk type) common return, lamp signal, manual telephone switchboard. This unit shall be equipped for . . . line and lamp jacks (for all stations, plus 10%) or nearest largest standard switchboard manufactured, cross-connecting cords and ringing and listening keys, (based on five for first 50

[Continued on page 210]

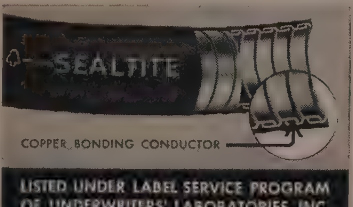
PROOF!

SEALTITE FLEXIBLE, LIQUID-TIGHT CONDUIT LICKS CORROSION

nd conduit failures—save replacement costs nd down time—by installing Sealtite!

altite is not the kind of conduit you put in and then art to worry about. It's in to stay. Come chemical mes, steam, salt spray, dirt and grime, what have you. Your wiring is procted—and you're sure of it!

Sealtite is flexible, can be cut at job te. It takes up movement and absorbs bration. And because it's easier to inall, especially in cramped quarters, ealtite saves money and materials not ssible when you use other methods.


SEALTITE
COPPER BONDING CONDUCTOR
LISTED UNDER LABEL SERVICE PROGRAM OF UNDERWRITERS' LABORATORIES, INC.

CUTAWAY of Type U.A. Sealtite shows tough polyvinyl chloride jacket over flexible metal core. Copper conductor wound spirally inside conduit provides positive ground.

WHERE TO GET SEALTITE—Electrical Wholesalers stock Sealtite in easy-to-handle coils, in black or gray. Ask for and get the quality conduit marked "Sealtite" and "Anaconda" on the cover. Buy it in long lengths on reels or in cartons and cut it on the job without waste. Your wholesaler also stocks liquid-tight connectors. Free Booklet S-542 gives full information on Sealtite. Write: Anaconda Metal Hose, P.O. Box 791, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. Sealtite is approved by Canadian Standards Assoc. 61146

EALTITE® flexible, liquid-tight conduit an **ANACONDA®** product lines plus one for each ten additional lines) buzzer and switch, headset and breast-plate transmitter with cord and plug, line terminals in rear. The cross-connecting cords shall be complete with supervisory pilot lamps.

Ga. Install at each location where shown a handphone on cradle desk (or flush or surface wall mounting with handphone) telephone with automatic dial and ringer. (Provide desk unit with 6-ft flexible cable and terminal block.)

Gb. Install in machine room a complete automatic exchange unit. The machine switching equipment shall be fully equipped for lines, plus 25% space for future expansion, including switching and rack facilities, ringing apparatus, rectifier equipment, battery and rack.

Ha. Install in each suite a flush (or surface) wall-type telephone provided with one pushbutton. (1) A talk and answer speaker mounted behind grille front with press-to-talk button; (2) a watchcase receiver, built-in transmitter and hook-switch; (1, 2) together with necessary terminals and backbox.

Hb. Install in vestibule a (1) loudspeaking telephone; (2) non-loudspeaking telephone with armored cord receiver and built-in transmitter; (1, 2) with . . . pushbuttons and cardholders (one for each suite). Outer frame shall be designed to contain government approved mailboxes. Backbox to be provided for the telephone in vestibule.

Hc. Install a mortise-type door-opener in main entrance door frame and fasten securely in place, and even with door lock.

11.14 Terminal-Strip Cabinets

Furnish and install where shown on plans, flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors, plus 10% spares. Terminal strips must be mounted on a sheet of insulating material.

11.15 Power Supply

The system shall operate from a dry-plate rectifier power-supply cabinet with a capacity of sufficient size to carry the load of the system. This unit shall have an input of 115 volts, 60-cycle ac derived from a separate circuit from the nearest lighting panel.

11.16 Wiring

All wiring shall be run in approved conduit in the same manner as for the

[Continued on page 212]

TESTED AND PROVEN . . .
THOUSANDS IN USE!

OSTER "100"
POWER DRIVE
FULL 2" CAPACITY

Here's the original, LOW PRICED Power Drive that continues to be the "first-choice" of factory maintenance men everywhere! Compact, lightweight (only 77 lbs.), the "100" is strictly a one-man machine yet does the work of *four* men! See it today.

ADD POWER TO *ALL* YOUR THREADING OPERATIONS

◀ quick, clean ream
Cutting off is fast . . . easy ▶
▲ Smooth, leakproof threads

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LIKE AN EXTRA PAIR OF HANDS

IDEAL

"WIRE-LUBE"®

Slides Wire Through Conduit, Makes Any Wiring Job Easier, Faster

Contractors agree, using Ideal "Wire-Lube" is almost like adding another helper on the job! Wires and cables **slip** through conduit, around bends and through tight spots. "Wire-Lube" takes the fight out of rubber, lead or plastic wire and cable, forms a slippery film to protect insulation against breaks, strains, and scrapes. Quickly applied by hand or brush, "Wire-Lube" dries to a fine lubricating powder that makes adding or removing wires easier later. Non-corrosive, non-combustible, and harmless to hands or clothes, it can be used in steel, aluminum and fiber conduit. Not suitable for asbestos-covered wire. One quart cans to 55 gallon drums.

And to make wiring easier still . . .

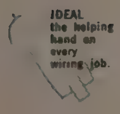
IDEAL STEEL FISH TAPE AND REEL

—flat oil-tempered spring steel simplifies wire pulling, won't break, kink or fray. Steel reel gives firm grip and extra leverage to push or pull tape through conduit—without strain. Also serves as container—keeps tape from springing loose—protects hands. Economical lengths of 50, 100 and 200 feet in ⅛" and ¼" sizes.

IDEAL ROUND FLEXIBLE LEADER

—music wire spring wound around a 20" airplane cable "smoothes out" tricky curves, guides fish tape into outlet boxes and around 90° bends, yet is tested to withstand 400 lb. pull. Attaches instantly to Ideal Fish Tape, handles up to six No. 10 wires.

SOLD THROUGH AMERICA'S LEADING DISTRIBUTORS • In Canada: Irving Smith, Ltd., Montreal



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IDEAL INDUSTRIES, INC., 1041-E Park Ave., Sycamore, Illinois IDEAL

Name____________________

Company____________________

Address____________________

City____________________ Zone______ State__________

lighting system. The wire shall be color-coded and in general shall be standard heavy-braided type, except in damp locations (or underground where it shall be lead-covered). (A) Twisted pair No. 19 B & S gauge and two No. 18 single B & S gauge. (B, D, G, H) Cable with two pair No. 18 B & S gauge, balance single or paired No. 22 B & S gauge. (F, G) Cable with pairs No. 22 B & S gauge, branches twisted duplex or triplex No. 19 B & S gauge. (D) One twisted pair No. 19 B & S gauge, one common No. 18 B & S gauge, plus one No. 18 B & S gauge for each signal.

11.17 Finish

Finish on instruments shall be standard insofar as possible, except annunciators and manual switchboards which shall be as approved by the architect.

11.2 Public Telephone Systems

11.21 Gauge

Furnish and install a conduit system for the public telephones as recommended and specified by the (name of local public telephone company) and described in these specifications and indicated on wiring plans.

Furnish and install outlet boxes as required by the telephone company. Where these outlets are combined with other outlets, proper barriers must be provided.

11.22 Terminal-Strip Cabinets

These cabinets shall be supplied and installed as required by the telephone company, less terminal strips; however, they must be of proper size and have the proper gutter requirements.

11.3 Sound Systems

A. Single-channel without intercommunication.

B. Single-channel and Intercommunication.

C. Two-channel with intercommunication.

D. Three-channel with intercommunication.

11.31 General

Furnish and install a (trade name/and or number) sound system (select type from A, B, C, D above) as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first-class operating condition.

[Continued on page 214]

SO EASY TO HANDLE
WB DYNAPRENE PORTABLE CORD

Smaller sizes are packed on spools in cartons . . . Larger sizes in coils, in knockout cartons . . . Easy to identify anywhere . . . Type, size and gage, clearly marked on jacket . . . Safe to recommend . . . Premium quality, long lasting, oil-resistant, neoprene jacket . . . U.L. approved.

Write for free Catalog PC-58 "Portable Cord and Cable"

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WHITNEY BLAKE CO.

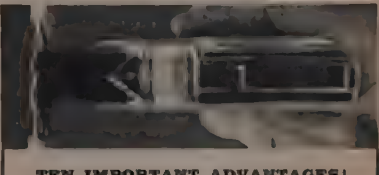
NEW HAVEN 14, CONNECTICUT / Telephone CHestnut 8-5515 / TWX: NH 84

Now! Tape...and tear...with one hand!

THIS BRAND-NEW DISPENSER makes handling plastic electrical tape a revelation! Far safer, too, because the cutter is permanently shielded . . . can't snag hands or clothes.

From beginning to end, you'll save time and trouble with J-M *Dutch Brand* Plastic Electrical Tape in this great new dispenser. And you'll like *all ten* of the big advantages shown on the right.

But, see for yourself! Get all the facts on Dutch Brand® Plastic Electrical Tape in the handy new dispenser from your J-M Dutch Brand Distributor. Or write to Dutch Brand Division, Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ont. Cable: Johnmanvil.



TEN IMPORTANT ADVANTAGES!

1. *Permanently shielded cutter!* 2. *No moving parts to snag hands, clothes!* 3. *Can't dull or clog!* 4. *"Tape-and-tear" with one hand!* 5. *Special "grip-strip" for faster starting!* 6. *Full 66′ of finest plastic electrical tape made!* 7. *Preloaded . . . ready to go!* 8. *Protects tape against dirt, grease!* 9. *Big center hole for easy handling!* 10. COSTS NO MORE THAN TAPE ALONE!

JOHNS-MANVILLE
DUTCH BRAND ELECTRICAL TAPE

BUCHANAN pres-SURE Romex Connectors

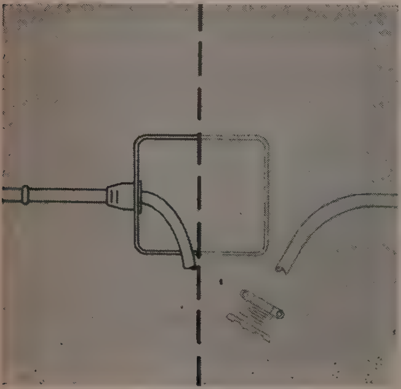
EASIEST, FASTEST TO USE

Just one piece to handle. Insert the pres-SURE Romex connector in the knockout, hold firmly against inside of box, give initial crimp with electricians' pliers, then complete crimp with 2 hand-squeeze. No screws, lock nuts or clamps to slow down your journeyman.

One man completes job first time around. Only pres-SURE Romex connectors can be inserted in boxes after wires have been run through knockouts. One journeyman can pull wires, install connectors, cut wires to proper lengths, staple wires close to boxes. No guesswork, no wasted wire, no time lost by make-up man.

Want more reasons why you should be using Buchanan pres-SURE Romex connectors? They extend less than ¾" into the box—that means more wiring room; large bearing surfaces distribute pressure on cable, minimize insulation abrasion; exclusive crimp-type installation assures permanently-tight, vibration-proof connections; no parts to work loose; special high grade aluminum won't rust.

Write for Bulletin. EC-5



Listed for 14/2, 14/3, 12/2, 12/3, and 10/2 nonmetallic sheathed cable. Catalog No. 1050 — An exclusive Buchanan product (U.S. Patent 2527227).

⅜" trade size fits standard ½ knockouts.

BUCHANAN a subsidiary of ESNA

BUCHANAN ELECTRICAL PRODUCTS CORPORATION
HILLSIDE, NEW JERSEY
In Canada: ESNA CANADA LIMITED, Toronto 16

11.32 Function and Facilities

The equipment shall perform the following functions:

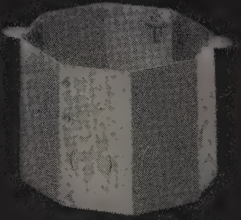
1. Receive and distribute radio program material to any combination of room speakers. (ABCD)
2. Distribute announcements from the console to any combination of room speakers. (ABCD)
3. Distribute disc-recorded program material to any combination of room speakers. (ABCD)
4. Receive and distribute tape-recorded program material for any combination of room speakers. (ABCD)
5. Receive and distribute program material from one of two remote program sources to any combination of room speakers. (ABCD)
6. Receive and distribute program material from two and up to possibly four remote program sources to any combination of room speakers. (CD)
7. Select and mix program material from two microphones for single-channel transmission. (ABCD)
8. Select and mix program material from four microphones for dual-channel transmission. (D)
9. Select and mix program material from two microphones and one other program material source (Radio, Phono, Remote No. 1, Remote No. 2, Tape) for single-channel distribution. (ABCD)
10. Select and mix program material from two microphones and one other program material source (Radio, Phono, Remote No. 1, Remote No. 2, Tape) for single-channel distribution, plus one other program material source (Radio, Phono, Remote No. 1, Remote No. 2 and Tape) or the local microphone for distribution via a second channel. (CD)
11. Select and mix program material from two microphones and one other program material source (Radio, Phono, Remote No. 1, Remote No. 2, Tape and Room Pickup), for distribution of separate programs on two program channels simultaneously plus one other program material source (Radio, Phono, Remote No. 1, Remote No. 2, Tape) or the local microphone via a third channel. (D)
12. Intercommunicate with any one room speaker by means of the program channel. (B)
13. Intercommunicate with any one room speaker without interrupting program material being distributed to any other room speaker. (CD)
14. Select the console monitor speaker or a console microphone for intercommunication with room speaker. (BCD)

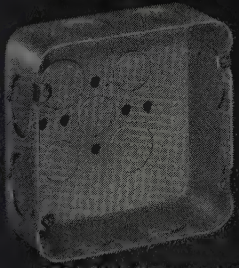
[Continued on page 216]

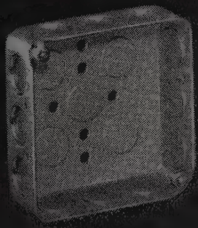
606—4" x 2"
Thru-the-Wall box

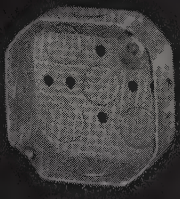
451—3 x 2" Switch box
2¼" deep "Q" clamp

425—3 x 2" Switch box
2" deep Griptite


272—Concrete box
3" deep

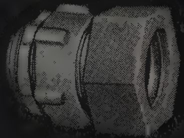

258—4 11/16" Square box
2⅛" deep

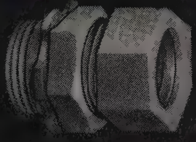

190—4" Square box
1½" deep

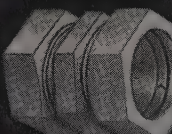

125—4" Octagon box
1½" deep

156—4" Octagon box
1½" deep N clamps

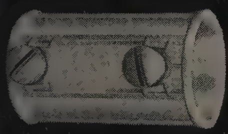
A box for every job . . .
A fitting for every need


1802—No thread
rigid connector


1902—E.M.T.
compression type connector

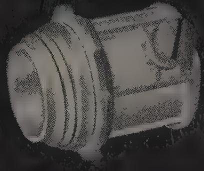

1922—E.M.T.
compression type coupling

2358—
Entrance cap


2622
set screw type coupling

2141—Non-metallic
cable connector

2202—Angle squeeze connector
90° two-piece type


2602
set screw type connector

Raco has the most versatile and complete line of roughing-in material you'll find anywhere. Shown here are some representative products of our extensive line. One thing is sure—whatever size, whatever type of box or fitting you require, Raco has it.

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ALL-STEEL EQUIPMENT INC., Aurora, Illinois

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For 2½", 3", 3½", 4" Pipe and Conduit

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2. Jam-Proof for safe threading by power or hand. Drive pinion kicks out automatically. Die head *Can't Jam . . .* avoids costly repairs and delay.

3. New Fast-Action, Cam-Type Workholder sets to size by quick turn of collar. Set screw holds work centered for perfect threads every time . . . adjustable for drip threads.

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RIDGID®

The Ridge Tool Company, Elyria, Ohio, U.S.A.

15. Visually indicate overload levels of program material by a neon indicator and provide for aurally monitoring program material from an external speaker. (A)

16. Aurally (monitor speaker) and visually (meter) monitor program material. (BCD)

17. Provide for an EMERGENCY switch that shall (1) Turn "on" the system (if off); (2) Indicate a red panel lamp when system is ready for operation; (3) Provide precedence by disconnecting all program sources and preset volume level; (4) Permit distribution of an emergency announcement by means of the monitor speaker to all rooms simultaneously—regardless of other control or switch settings. (ABCD)

18. Transmit program material to all speakers simultaneously, regardless of room-speaker switch settings, by placing the function switch in the ALL-CALL position. (ABCD)

19. Select and preset any number of room switches before distributing program material. (ABCD)

20. Provide means to record any program material on an external tape recorder. (ABCD)

21. "Preview" and adjust program material through the console monitor speaker before transmission to room speakers. (ABCD)

22. Distribute a raucous tone signal from built-in oscillator to any combination of room speakers. (ABCD)

23. Adjust volume of console output from a remote location. (ABCD)

24. Receive a reply from a classroom only with the knowledge and active assistance of the teacher—thereby assuring "privacy." (BCD)

25. Provide means at the console to aurally and visually indicate room(s) which wish to communicate with the console. (BCD)

26. At each location shown on the plans, there shall be installed a special RED telephone handset which when lifted from the cradle shall (1) Turn "on" the system (if "off"); (2) Indicate by means of a red lamp in the cradle when system is ready for operation; (3) Provide precedence by disconnecting all other program sources; (4) Permit distribution of an emergency announcement from the handset to all rooms simultaneously—regardless of position of console switches and controls; (5) Provide audible signal in handset to indicate message is being distributed. (ABCD)

27. Same as above but add: (6) By pressing momentary switch in handset cradle, distribute a siren tone to all rooms simultaneously. (ABCD)

[Continued on page 218]

NO BOLTS, NO SCREWS, NO DRILLING

with new Permacel Junction Box Mount epoxy adhesive
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The electric power required to operate a 25 cent 100 watt incandescent lamp will amount to nearly $2.50 before the lamp burns out. The efficiency with which a lamp converts electric power into usable light is an important factor in considering lamp value.

TWO 100's WON'T DO THE WORK OF ONE 200

A 200 watt incandescent lamp produces approximately 3800 lumens. Two 100 watt incandescent lamps produce approximately 3400 lumens — about 10% less light.

YOU CAN CHECK YOUR LIGHTING AGAINST RECOMMENDED LEVELS FOR ALMOST 700 DIFFERENT JOBS

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Your Best Buy in Lamps

CHAMPION LAMP WORKS, Lynn, Massachusetts

CHAMPION INCANDESCENT-FLUORESCENT

11.0 Signal

28. By actuating one of several remote-emergency alarm switches it shall be possible to automatically perform the following :(1) Turn "on" the system (if "off"); (2) Provide precedence by disconnecting all other program sources; (3) Distribute a siren tone to all rooms simultaneously, regardless of the position of the console switches and controls. (ABCD)

29. Provide facilities for a selective-ringing, selective-talking telephone system without the use of additional wiring between the console and room(s). (ABCD)

30. Provide for the generation and distribution to all classroom speaker(s) simultaneously, of a tone signal keyed by a single-circuit program instrument supplied on another contract, for indicating beginning and end of classroom period. (ABCD)

31. Provide for the generation and the distribution of a tone signal to classroom speakers for indicating beginning and end of classroom period. Circuit shall provide for connecting speaker lines as desired through a cross connect panel to a 2-, 4-, or 6-circuit program instrument supplied on another contract. (ABCD)

32. Provide facilities for priority control of speakers connected to remotely located independent public address systems. (ABCD)

11.33 Equipment

A. Central Control Console

All sections of the console cabinet shall be constructed of cold rolled No. 16 gauge steel and finished in ... enamel. The cabinet shall measure ... high by ... wide by ... deep and its front face shall slope at an angle from its vertical plane. The unit shall be provided with a working desk surface. The console shall mount all switches, controls and indicator lights (where necessary) for the proper operation of the system.

1. Program Channel Preamplifier and Mixer (One for Single- and Two-Channel Systems and Two for Three-Channel Systems)

The preamplifier shall have facilities for selecting and mixing program material from two microphones and one other program source (Radio, Phono, Remote No. 1, Remote No. 2, Tape or Room Pickup) for distribution to booster amplifiers. The unit shall incorporate an output function selector switch and its use shall permit the pre-selection of program material before distribution to any room speaker, permit distribution of program material to all room stations simultaneously regardless of the position of the out-

[Continued on page 220]

Bring out the best in Electric Heating with Honeywell quality controls

The new Honeywell T462 Line Voltage Thermostat offers the very finest for your economy-minded customers. A beauty in any room, this compact new thermostat gives dependable, worry-free performance—high load capacity plus accuracy and responsiveness. The new T462 was especially developed for electric heating, with a control range from 40°-85° with less than one-half degree differential. The T462 offers everything you could ask for in a quality-built line voltage thermostat.

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T462A—SPST Switching With Manual Single-Line Break in "No-Heat" Position.

T462B—SPST Switching With Manual Double-Line Break in "Off" Position.

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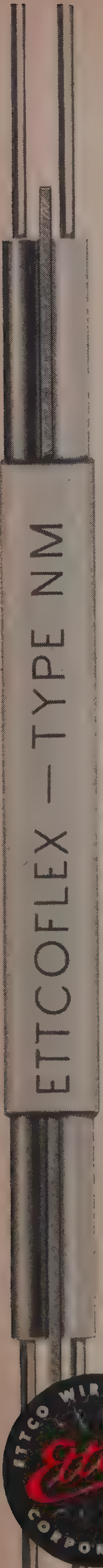
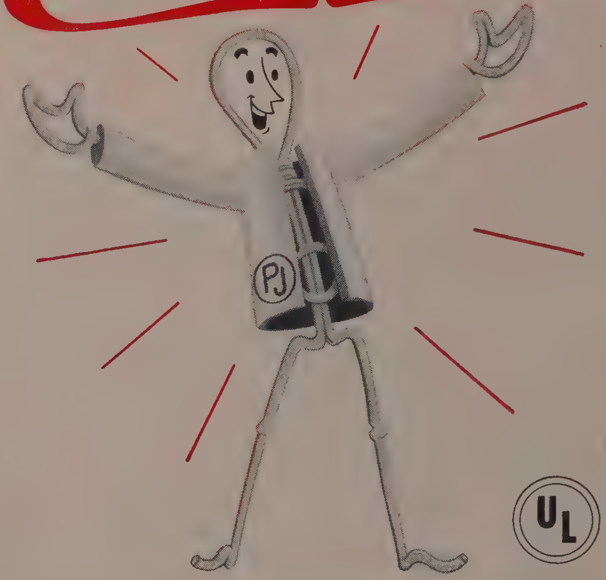
A brand new jacket for Ettco Flex





The all-new Ettco Flex* non-metallic sheathed cable (Type NM) is now P.J. (plastic jacketed).

The new Ettco-Flex P.J. is the first completely new product of its kind in the cable industry for over a quarter of a century. This is a result of ETTCO's constant research and development.

New Ettco-Flex is better by far because it features . . .

- Much smaller diameter than any competitive product.
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- No messy paper wraps.
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- All sizes with and without ground wire.
- Packaging in new convenient white carton.

See and "Feel" the new Ettco-Flex P.J. at your local distributor.

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put selector switches; in the emergency position, this switch shall cut off all program material and shall permit announcements to be made to all speaker stations regardless of any control settings. Receptacles shall be furnished on the front panel for the local microphone, tape-playback and tape-record inputs. Pilot lamps shall clearly indicate "Power On" and "Emergency Ready." The panel shall measure . . . high by . . . wide, and shall be attractively finished in . . . enamel with all controls and all switches clearly labeled. The preamplifier shall meet the following minimum specifications: Frequency response shall be from 50 to 15,000 cps ±2 db. Hum and noise shall be −60 db below rated output, and its gain shall be 60 db across 100,000-ohms load for 5-volt output. Treble control action shall be plus 8.5 db to −10 db at 10 kcs, and the bass control circuit shall permit control from plus 12 db to −11 db at 60 cps.

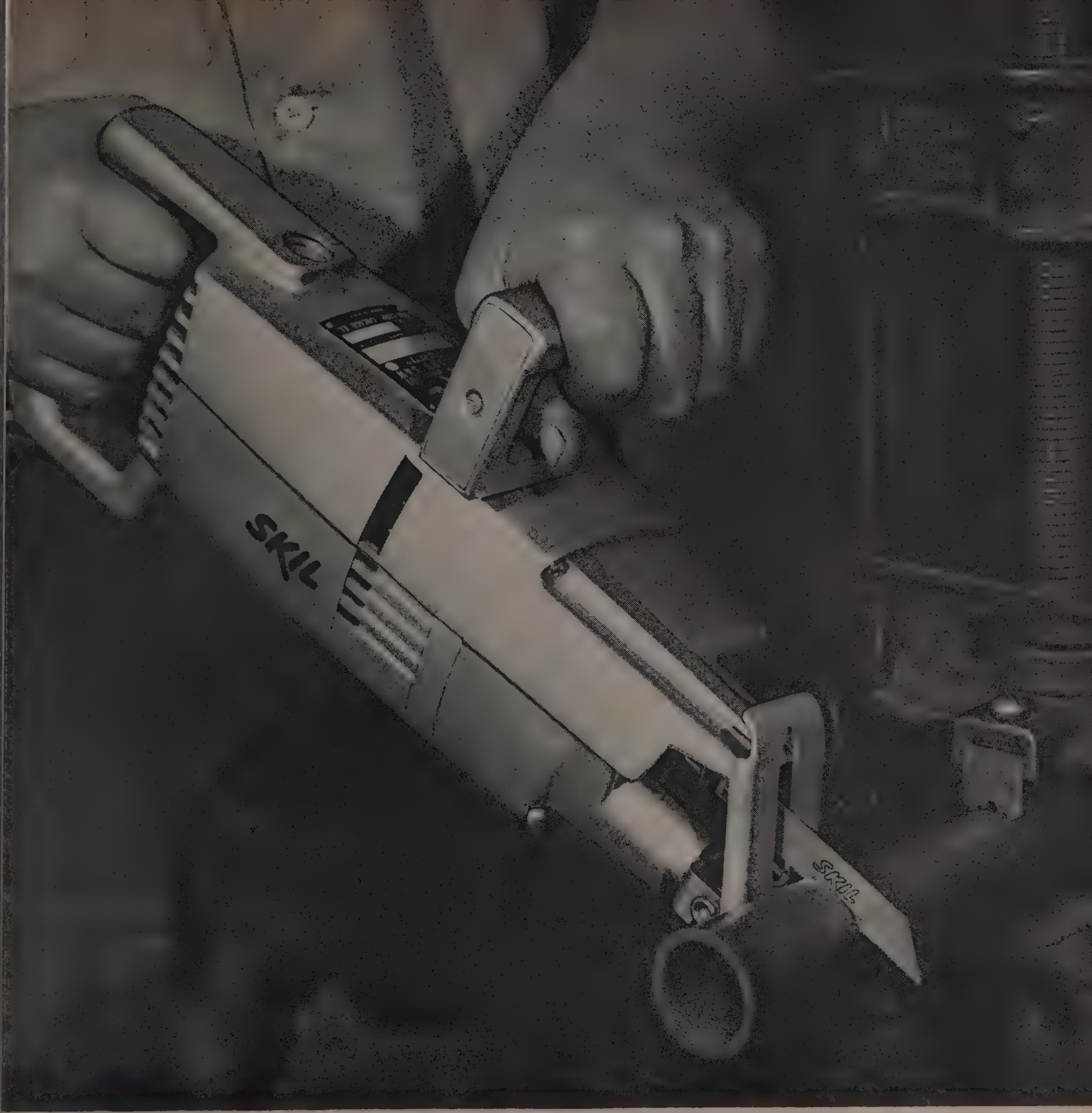
2. Intercommunication - Auxiliary Channel Control Panel

The Intercom-Auxiliary channel shall have provision for inputs from a radio tuner, phonograph, tape recorder, a 600-ohm input from two remote lines and a 50-ohm input from a local microphone. It shall be designed to operate with an intercommunication amplifier rated at (10 or 30) watts. The unit shall have four controls, logically grouped and interrelated; Monitor selector (Chan "A," AUX, Chan "B"); Monitor volume, Program group selector (Radio, Phono, Remote No. 1, Remote No. 2, Tape) Aux-Volume, Function Selector (Local Mic, Aux.) Talk-Listen (Talk-Listen position shall be spring return), Power Switch. The panel shall also incorporate a db meter and monitor speaker, which shall also be utilized for the intercommunication function. The meter shall indicate the level of the output signal from either the program preamplifier (2) or intercom-auxiliary channel.

3. Program Amplifier(s) (One required for ABC and two required for D)

The program amplifier shall be capable of delivering 30 watts—(up to 60 rooms), 60 watts—(up to 100 rooms) or 100 watts (over 110 rooms) of audio power at less than 1% distortion when operated from a 60-cycle power source at 110 to 120 volts ac. Maximum power consumption shall not exceed (150 watts for 30-watt ampl.; 260 watts for 60-watt ampl.; 300 watts for 100-watt ampl.) at rated

[Continued on page 222]



Cuts 2-inch cast iron pipe in less than 2 minutes!

New Skil Model 701 . . . world's only portable electric, metal-cutting hacksaw!

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made specifically for fast cutting of
metal or highly abrasive material, in-
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minute for extremely fast cutting of different gauges and densities of metals and with longest blade life. Standard equipment includes steel carrying case and 4 assorted blades.

Ask your Skil distributor to demonstrate either or both Recipro Saw models. Look under "Tools-Electric" in the Yellow Pages. Or write: Skil Corporation, Dept. 130E, 5033 Elston Ave., Chicago 30, Ill.

Improved All-Purpose Model 700! Newest version of world's first 2-speed reciprocating saw. 2600 s.p.m. speed for metal; 3500 s.p.m. speed for wood, compositions, plastic.

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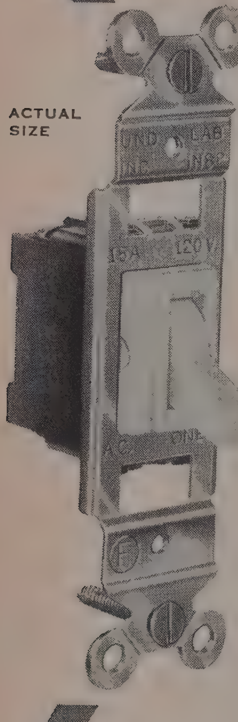

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Another fine product of Circle F know-how

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TRENTON 4, NEW JERSEY

power output. An input signal of 2 volts shall be sufficient for driving the amplifier to full output when the input impedance is ½ megohm. The amplifier shall provide an output of 25 volts balanced line for speaker and distribution line matching. The output regulation shall be within 2db from no load to full load—100, 200 and 4000 cycles, and it shall have a frequency response of 50 to 15,000 cps plus or minus 1 db. (ABCD)

4. Intercom-Auxiliary Channel Amplifier

The amplifier shall operate from a 60-cycle 117-volt ac source and shall consume no more than 150 watts at full output. It shall be designed to deliver (10 or 30 watts) when driven by an input signal of 6 mv. Distortion shall be less than 3% at rated output and the unit shall be capable of operating within 3db over a range of frequencies from 50 to 15,000 cps. The amplifier shall provide for a 25-volt balanced line and center tap at the output. (CD)

5. Room Selector Switchbanks

Selector switches shall be supplied for . . . rooms (insert required number). There shall be (10 or 20) switches to a panel and these switch panels shall be designed to mount on the sloping front plane of the console cabinet. The unused panel space shall be filled with blank panels. Each panel shall be finished in . . . enamel. Each room selector switch shall be of double-pole, level-action type. It shall have four positions clearly marked "A," "B," "OFF," "COMM." The panel shall be equipped with an $\frac{11}{32}$-in. wide metal channel which shall accommodate room identification strips. Each switch shall be supplied with a telephone-type screw-on knob. Possibility of cross-talk between channels shall be minimized. Separate lug connectors shall be available for each room pair in addition to an appropriate number of lugs for shields.

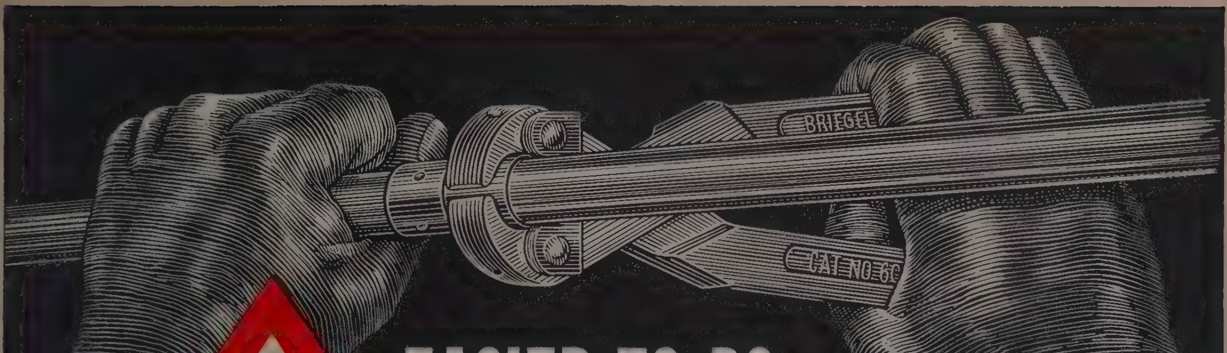
If room annunciation is desired, add the following:

(a) Annunciator shall have its indicators positioned directly adjacent to each room selector switch. A room calling the console shall activate a buzzer at the console and shall cause the annunciator to indicate the room. (ABCD)

6. Radio Tuner

The radio tuner shall be superhetrodyne receiver capable of program reception from FM stations over a frequency range of 88 to 108 mcs and AM stations over a frequency range of 530 to 1650 kcs. It shall be

[Continued on page 224]



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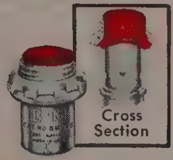
INDENTER FITTINGS and TOOLS

Here is the combination that is unbeatable when it comes to easier E.M.T. installation at less cost. New lightweight plier size indenters make setting up thin wall conduit a breeze. B-M fittings are neater too! No unsightly nuts or projecting set screws.

A few more of the plus features of B-M fittings are Concrete tight—Vibration resistant—Extra heavy bright zinc plate, salt spray and acid drip tested for corrosion resistance—Extra heavy positive bonding locknuts—Smooth rounded edges or bushed throat type connectors that prevent insulation damage—All steel construction with extra heavy gauge wall thickness.



Red Throat
BM-21B
½″ Connector

Red Throat
BM-22B
¾″ Connector

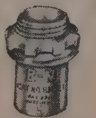
Red Throat
BM-23B
1″ Connector

BM-41
½″ Coupling

BM-42
¾″ Coupling

BM-43
1″ Coupling

BM-51 BM-52
½″ Offset Connector
¾″ Offset Connector



BM-21
½″ Connector

BM-22
¾″ Connector

BM-23
1″ Connector

BM-No. 600
Changeable Jaw Indenter

BM-No. 1000
Handvise for ½″, ¾″ and 1″ E. M. T.

BM-No. 100
Cutter for ½″, ¾″ and 1″ E. M. T.

BM-No. 607
½″ Indenter
BM-No. 608
¾″ Indenter

All B-M indenter type fittings far exceed the requirements of U. L. file card E 10863 and Federal Specifications W-F-406.

BRIEGEL METHOD TOOL CO.
GALVA • ILLINOIS

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...yet it costs no more than the old gray box!

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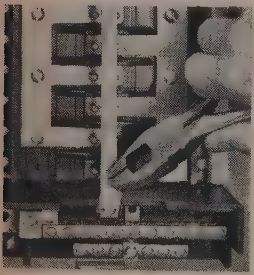
You'll like Safetybreaker's 2-position action, too. No tripped mid-position to confuse the housewife . . . eliminates costly, needless callbacks.

Fastest, easiest N.I. system by far

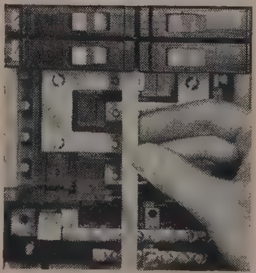
No special tools or "can openers" needed!

Cutler-Hammer's simplified "up-down" system for non-interchangeability is as far ahead of competition as the Safetybreaker's modern styling. No fussy keying system. It's impossible to omit or incorrectly position pins or tabs.

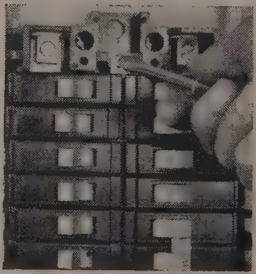
Here's how it works:



1. Simply tear off soft plastic spacers to loosen locking bar and screws.



2. Plug Safetybreakers into top portion of panel, slide bar to top of panel.



3. Plug in remaining breakers, tighten two screws to lock. That's all!

Call your distributor and ask for a demonstration, or write for free 36-page Safetybreaker Selection Guide, publication ED125—K241.

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CUTLER-HAMMER

CONTROL

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

designed to operate from a 117-volt, 60-cycle source. Power consumption shall not exceed 60 watts. There shall be a visual tuning meter on the front panel for determination of exact station position. The unit shall incorporate FM antenna inputs of 75 or 300 ohms for use with an external FM antenna. A minimum of 11 tubes shall be provided. The FM section of the tuner shall contain two stages of IF amplification and two stages of limiting. Band width shall be 180 kcs. The tuner shall include an AFC circuit to prevent drift and it shall contain provision for defeating the AFC. FM frequency response shall be from 50 to 15,000 cps plus or minus 1½ db, and 2.5 microvolts shall provide 30 db quieting at 75 ohms input. An automatic volume control circuit on both the AM and FM channels shall insure selectivity under strong signal conditions.

The AM section shall contain two stages of IF amplification and the band width shall be 10 kc. Frequency response shall be from 30 to 7000 cps. At 1-volt output, distortion shall not exceed 0.8% and 5 microvolts shall provide 0.5 volt output. The tuner shall be finished in . . . enamel and attractively screened to indicate station settings and controls. Oscillator shielding shall conform to FCC specifications for minimum radiation. (ABCD)

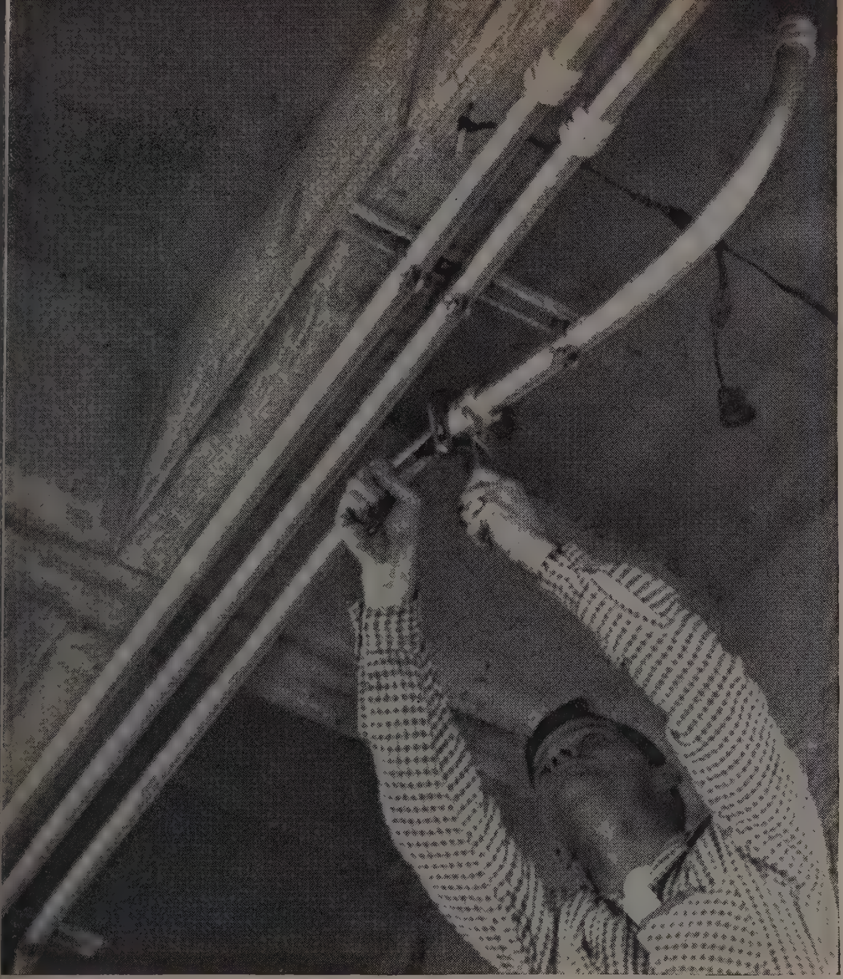
7. Record Player

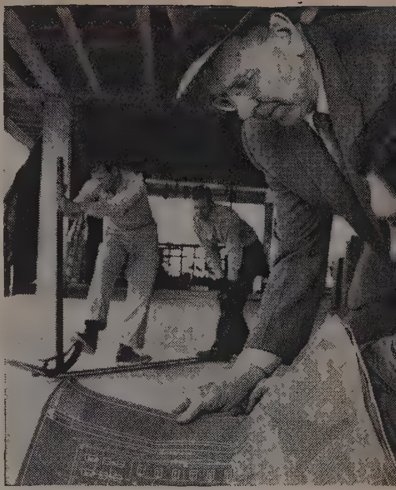
Note: Select (a) or (b).

(a) The record player shall be of the automatic type capable of handling a 1-in. stock of 7-in., 10-in. or 12-in. diameter records, and shall be capable of playing at all four standard speeds of 16⅔, 33⅓, 45 and 78 rpm. The mechanism shall be designed to automatically shut-off after the last record has been played. The unit shall incorporate a switch which shall enable the operator to manually place the tone arm on the record if desired. The unit shall be effectively noise free and shall incorporate a high-quality ceramic cartridge with sapphire tipped stylii capable of passing signals over a range of frequencies from 30 to 15,000 cps. The record changer shall incorporate a removable plug-in-type head. The unit shall mount in a pull-out drawer located in the pedestal of the console.

(b) The record player shall be a manually operated equipment capable of handling records with diameters from 7 in. to 16 in. at any one of the four standard turntable speeds of 16⅔, 33⅓, 45 and 78 rpm and at variable speeds from 16 to 20 rpm and 29 to 86 rpm. An adapter shall

[Continued on page 226]





Over 29,000 ft. of SPANG Conduit was installed i the Fireman's Fund Insurance Building, Atlant Electrical Contractor T. H. Fulton reports eas working qualities of SPANG Conduit helped kee project far ahead of schedule.

Architects: Saggus, Williamson, Vaught & Spike Atlanta
General Contractor: Barge & Company, Atlanta
Electrical and Mechanical Engineers: Newcomb Boyd, Atlanta
Mechanical Contractor: Sockwell & Compan Atlanta
Electrical Contractor: Fulton Brothers Electrical Co., Atlanta
SPANG Distributor: Graybar Electric, Atlanta

SPANG® CONDUIT

Electric heating wiring protected by SPANG conduit in new Atlanta building

The new Fireman's Fund Insurance Building will be one of the first Atlanta buildings to be heated electrically next winter. And Spang Conduit was chosen to protect the wiring in this installation.

The 460-volt electric system in this all-electric, three-story 66,000 sq. ft. building calls for 1600 amps with provision for 3000 amps. It serves three central air conditioning units, lighting and power as well as the electric heating. Over 29,000 ft. of Spang HD Galvanized Conduit and spanGleam EMT were installed by Fulton Brothers Electrical Company, Atlanta, to provide top-quality wiring protection.

Mr. T. H. Fulton, president of Fulton Brothers, says, "We take pride in how our finished work looks, and Spang Conduit presents an excellent appearance in exposed locations. The conduit was easy to bend and thread, helping us stay far ahead of schedule.

"Spang is one of the most satisfactory conduits we have ever used. This fact, plus the wonderful service and delivery we get, makes Spang a product we us wherever possible."

You can assure yourself of top-qua ity, trouble free conduit installatior with Spang Conduit. Try it and see! L your nearby Spang Distributor serv you. He carries the complete line of top quality Spang Conduit and Fittings.

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ARMCO National Supply Division

NEW Products

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Conductor Phase Identification Set Saves Labor Costs
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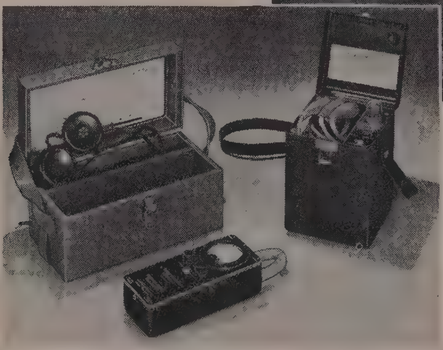
The Biddle Conductor Phase Identification Set employs a unique circuit that provides positive and reliable identification *without the need for removing all safety grounds.* Transmitter can be operated from either 60-cycle supply or self-contained dry cells. The detector is similar to a clamp-on ammeter. When clamped around A phase conductor, the pointer deflects left; when clamped around B phase conductor, it deflects right; when clamped around C phase, there is no deflection. Pick-up coil and earphone unit is used with transmitter to identify the cable itself. This means of positive cable identification results in safer operations and reduced labor costs.

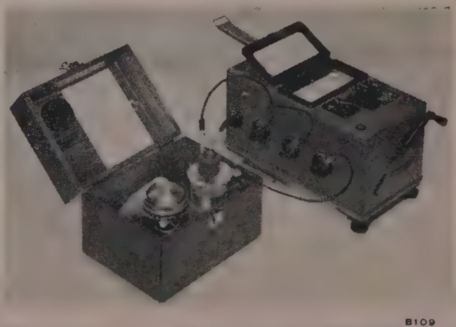
Write for BULLETIN 82ECM



Complete set includes transmitter, phasing detector and cable identification detector.

Biddle-Balsbaugh Test Cell Kit for Liquids

This kit is used with a Megger insulation resistance tester to make resistivity measurements of insulating oils and other liquids. Useable at test voltages up to 5,000 volts d-c. For complete details—
Write for BULLETIN 21-OCECM



B109

JAMES G. BIDDLE CO.
Electrical and Speed Measuring Instruments
1316 ARCH STREET • PHILADELPHIA 7, PENNSYLVANIA

be furnished for operation at speeds of 45 rpm, and a strobe disc shall be provided for speed testing. The unit shall contain a shaded 4-pole constant-speed motor which shall be capable of driving a statically and dynamically balanced 3⅜-lb heavy-gauge turntable. The unit shall be equipped with a heavy rubber mat, and shall incorporate a removable plug-in-type head. Speed variation shall be less than 1% and flutter index shall be less than 0.5%. Power requirements shall not exceed 15 watts, and rumble shall be −40 db. The unit shall be mounted in a pull-out drawer located in the pedestal of the console.

8. Privacy

It shall be possible to incorporate a complete privacy feature into the school console system without any additional wiring. The privacy unit shall prevent the console operator from monitoring any room without consent of the room's occupant, but shall not interfere with the transmission and quality of program material, voice, or time signals from the console.

The unit shall incorporate facilities for generating an intermittent signal in any classroom when the console function selector lever is in the listen position and switch for the classroom at the console is in the COMM position.

9. Priority Control

It shall be possible, through the use of the room speaker switches of the console, to transmit regular programs from the console to the remote system speakers (auditorium, gymnasium, etc.). In ALL-CALL and EMERGENCY broadcasts from the console, the relay shall automatically transfer the remote system speakers from the remote amplifier output to a speaker line from the console. Provision shall be made for visual indication at the console when the remote system is "off" or "on."

10. Remote Control

The unit shall provide remote control of the volumes of two microphone channels. These controls shall be mounted on a 2-gang plate designed to mount on a 2-gang plaster ring located as shown on the plans.

11. Emergency Signaling

The console shall include the necessary equipment required so that EMERGENCY - DISASTER telephones located at strategic points in the school may be capable of broadcasting EMERGENCY announcements over the sound system without the use of manual controls either at the console or at remote locations. The telephones shall, when the hand-

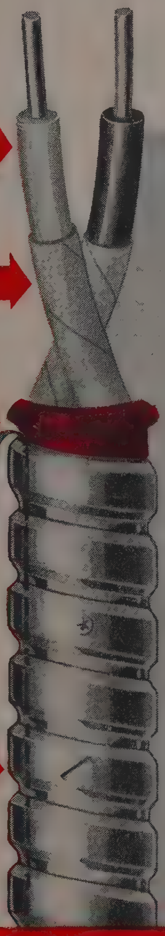
[Continued on page 228]

CRESCENT

ABC ARMORED CABLE

TYPE ACT

With Improved Features



PLASTIC INSULATED CONDUCTORS are clean, easy stripping, with solid, clear colors, and minimum diameter for easier installation in boxes.

PAPER TAPE which is tough, moisture-resistant yet easily removed, gives protection to the insulated conductors.

INSULATED BUSHING for protection against sharp ends of armor, furnished with each coil of cable.

BOND STRIP UNDER ARMOR is used in all sizes. A flattened aluminum bonding wire in contact with the under side of each convolution of the galvanized steel armor assures a permanent, low resistance through armor to ground.

PREFABRICATED BREAKING LINES

At intervals of every 1½ inches on CRESCENT ABC Armored Cable you will find a small cut mark. This cut mark shows the location of a prefabricated breaking line inside the armor.

The Accent is on Quality

EASIER
QUICKER
SAFER

Only a few short strokes of a hacksaw guided by the cut mark are required to cut through ONE outer ridge, and a bend by hand severs the armor. By actual test, this saves 30% of the time ordinarily required. A clean separation results, with no sharp edge. There is no chance of injury to insulation because only one OUTER ridge is cut. The fabricated breaking lines in the armor are so made that THERE IS NO REDUCTION of tensile strength, bending qualities, crushing resistance or electrical conductivity. This armor construction meets all requirements of Underwriters' Laboratories.

OVER 75 YEARS EXPERIENCE

CRESCENT INSULATED WIRE & CABLE CO., INC.
TRENTON, NEW JERSEY

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BOSS

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BOSS J.I.C. and NEMA wiring boxes, trough and wireway provide protection against oil, water, dust or dirt. All BOSS boxes and wireway are phosphatized before baked enamel finish is applied.

"Specials" are quoted promptly, fabricated accurately to your specifications and serviced for quick shipment.

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THE HUENEFELD CO. ENGINEERED PRODUCTS DIVISION
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set is lifted from the cradle, automatically turn the system "on," if "off," indicate by means of a pilot jewel light when the system is ready for operation, preset the volume level, permit distribution of an emergency announcement to all speakers in the system, and provide an audible side tone in the handset to indicate that the message is being transmitted.

(a) It shall also be possible to distribute a siren signal rising from 610 to 1040 cps in 5 seconds and declining to 610 cps in 7 seconds for Air Raid or Fire Alarm signals.

12. Time Signals

Note: Select (a) or (b).

(a) The console shall incorporate the necessary circuitry so that a constant tone signal may be broadcast to all speaker stations simultaneously when activated by a pulse from an external program instrument.

(b) The console shall incorporate the necessary circuitry so that a constant tone signal may be broadcast to speaker stations connected to any one of two, four or six program schedules, determined by the size of program instrument installed and cross-connect panels. The cross-connect panels shall be installed in the console. This feature shall be accomplished with or without individual room speaker relays.

B. Loudspeakers

1. At each location where shown on the plans, install a (surface-mounted; flush mounted) loudspeaker assembly consisting of an 8-in. PM speaker having a magnet weighing 2.15 oz, and constructed of Alnico V. Each speaker shall incorporate a line-matching transformer, and shall be housed in an attractive (surface type or flush box with matching grille to blend with the decor). The over-all frequency response shall be from 60 to 10,000 cps and the assembly shall be capable of handling 10 watts of power. The line-matching transformer shall be tapped at ½, 1 and 2 watts.

2. Loudspeakers (Corridor Type)

At each location where shown on the plans, install a similar loudspeaker as shown above, but install in a 2-way housing, constructed of metal. The baffle shall be adequately treated inside to prevent metallic resonance.

3. Loudspeakers (Auditorium Type)

At each location where shown on the plans install a 12-in. loudspeaker having the following minimum specifications.

The unit shall be capable of handling 25 watts of continuous power and shall have a frequency response of from 45 to 15,000 cps. It shall in-

[Continued on page 230]

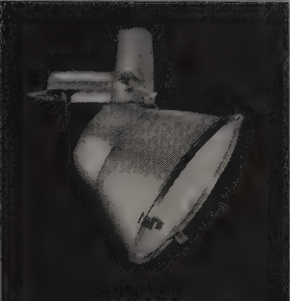
60-30-3 No. 115-40-5B
RIGID POLES

No. 199-Series
HIGH STRENGTH HINGED POLES

No. 4213-P
ALUMINUM FLOODLIGHT

No. 3807
ELIPTOR FLOODLIGHTS

No. 2001 REAR
SERVICE FLOODLIGHT



No. 4411-P
ECONOMY FLOODLIGHT

No. 5442
ULTRA-LITE

No. 5452
QUAD-OVAL LUMINAIRE

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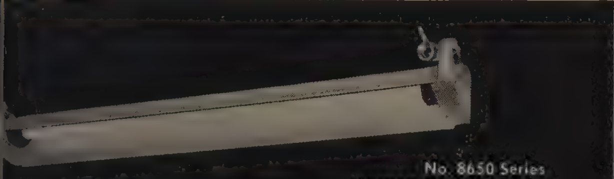
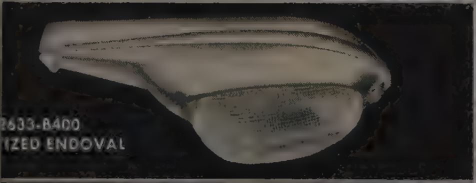


No. 8650 Series
FLUORESIGN LUMINAIRE

No. 9946-V
HIGH LEVEL AREA-LITE



2633-B400
IZED ENDOVAL

2513-B175
TIZED URBANOVAL

No. 2274
ENDOVAL

No. 2501-B250
URBANOVAL

No. 6823-NFH
QUARTZOVAL "500"

...you'd go a long way to being convinced that Leviton makes a specification grade device to last a lifetime. For example:

- The principal working part is a one-piece heavy phosphor bronze contactor that retains its elasticity through millions of cycles.
- The critical contact points are of special heavy silver alloy, selected for high conductivity and low oxidation to prevent arcing.
- Quality control during production makes certain of perfect alignment of contact points and smooth functioning of the switch.
- All parts are assembled in extra heavy molded phenolic—Leviton switches can take a beating!
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- Available in single pole, double pole and 3-way . . . in either brown or ivory phenolic. Rating 15A 125-277V, AC only and 20A 125-277V AC only.

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clude a built-in LC-type dividing network. The woofer portion of the speaker shall handle frequencies up to 2000 cps, while the tweeter portion shall handle frequencies over 2000 cps. The magnet of the loudspeaker shall be constructed of Alnico V and the unit shall be provided with a constant-voltage transformer having taps at 2, 4, 8, and 16 watts. The speaker assembly shall be properly housed in a wooden cabinet (either recessed behind a decorative grille or mounted on the surface of the wall).

4. Loudspeakers (Weatherproof Type)

At each location where indicated on the plans, install a loudspeaker (weatherproof, if located outside of the building) of the re-entrant type constructed of metal and capable of handling 12 watts of continuous power, and having a frequency range of from 300 to 10,000 cps.

C. Microphones

1. Locate at the central control console a special dynamic microphone assembly consisting of a weighted base—incorporating a momentary DPDT spring-return switch with self-wiping silver-plated contact to which shall be attached a 12¾-in. length of chrome-finished flexible-gooseneck section. At the top of the latter shall be firmly and attractively attached a sensitive, rugged, microphone which shall provide a frequency response of 50 to 7500 cps. The output level shall be –56 db. The base shall be fitted with a locking-type receptacle to accept a locking-type microphone cable connector.

2. Locate in the (auditorium, gymnasium, etc.) a high-quality (cardioid or dynamic) microphone capable of providing for a frequency response of from 50 to 15,000 cps. The output level shall be –87.9 db, and the unit shall be designed for (unidirectional-omnidirectional) pickup pattern. It shall be mounted on an attractive adjustable floor stand which may be adjusted from 24 in. to 64 in. in height. The stand shall be finished in chrome with a grey crinkle base.

D. Independent Systems

The amplifier shall be installed where shown on plans on a special wall bracket, which shall permit the amplifier to be lowered from the wall to an angle of 45 degrees for the purpose of turning the equipment on and off and for presetting of volume and tone controls. The unit shall be supplied with a control-guard locking plate which shall secure the amplifier to the bracket and protect the controls from unauthorized tampering.

[Continued on page 232]

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- Performance proved
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LIDSEEN
"Chicago" benders
are your
BEST BUY

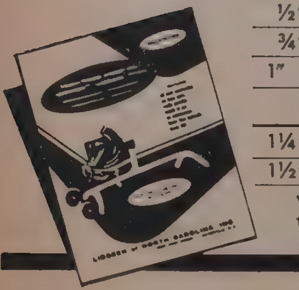
Illustrated:
No. 5100 *for bending ½", ¾" and 1" rigid conduit*

It's designed by Electricians for Electricians!

Now! The Lidseen "Chicago" Bender meets the electrician's requirements more than ever. This improved "Chicago" bender incorporates all the additional features that electricians felt could make it the best on-the-job tool. It's lighter in weight, adjusts to any working height, wheels for easier portability and *all* models feature Lidseen's famous calibrated degree scale. **Lidseen "Chicago" Benders are at least twice as fast as hydraulic and work equally well on Aluminum or Steel Conduit.** Remember . . . before you buy just any bender, ask the electrician who is using a "Chicago" Bender; he will tell you it's the finest tool available and at a price that is eminently reasonable.

Bending Circles and Inside Radius

	No. 5100	No. 5300
½" Conduit or Pipe	2³⁄₁₆"	EMT 4"
¾" Conduit or Pipe	4⅛"	EMT 5"
1" Conduit or Pipe	5¼"	EMT 6"
	No. 5200	**No. 5400**
1¼" Conduit or Pipe	6⅞"	EMT 8"
1½" Conduit or Pipe	8¼"	EMT 10"



Write for NEW illustrated folder on How to Bend Conduit

LIDSEEN
OF NORTH CAROLINA, INC.
1050 FIRST STREET, HAYESVILLE
NORTH CAROLINA

11.0 Signal

The amplifier shall be capable of delivering 60 watts of audio power at not more than 2% distortion at 100, 400 and 5000 cycles. The frequency response shall be plus or minus 1.5 db from 20 to 20,000 cps. The output regulation shall be within 2 db from no load to full load at 100, 400 and 5000 cycles. The amplifier shall provide input facilities for 50 ohms, 200 ohms, high impedance. One mic channel shall provide the facility of switching to accept a signal from a radio tuner, crystal cartridge or low-level magnetic-phonograph pickup-cartridge source. The magnetic input shall provide RIAA playback equalization and produce rated power with an input signal of not greater than 10 mv at 1000 cycles. Each input shall be provided with a volume control and separated preamplifier incorporated in the amplifier, and the unit shall provide for bass control of plus or minus 14 db at 60 cycles and treble control of plus or minus 12 db. All inputs for microphones, etc. shall be provided with special lock-type positive-polarity receptacles. The amplifier shall have output impedance taps of 4, 8 and 16 ohms as well as taps at 70 volts and 25 volts, and ac receptacle shall be provided at the rear of the unit for powering associated equipment. Provisions shall be made for controlling the volume of all four inputs from a remote point by means of a 4-channel remote controller. The unit shall be finished in . . . enamel.

All wiring shall be No. 20 AWG, twisted stranded cable covered by an over-all plastic jacket. All speaker cables shall be covered by an over-all braided shield, with an over-all plastic jacket.

Low-level and high-level lines shall be installed in separate conduits, and shall under no conditions be run in the same conduit.

11.4 Paging Systems

A. Lamp annunciator, three-call.
B. Central code transmitter.
C. Voice, multiple circuit.

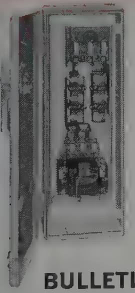
11.41 General

Furnish and install a (trade name and/or number) paging system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications, and left in first-class operating condition.

11.42 Operation

A. Lamp annunciator: In corridors,

[Continued on page 235]

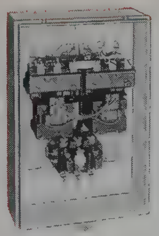


BULLETIN 712

Size 1 combination starter with fused disconnect switch

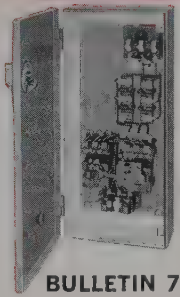
BULLETIN 713

Size 1 combination starter with circuit breaker



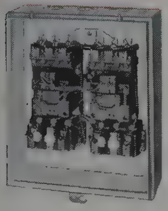
BULLETIN 705

Size 2 across-the-line reversing starter with overload relays



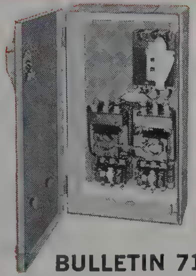
BULLETIN 706

Size 1 reversing starter with fused disconnect switch



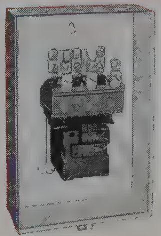
BULLETIN 715

Size 1 across-the-line, multi-speed starter with overload relays



BULLETIN 717

Size 2 multi-speed starter with circuit breaker



BULLETIN 702

Size 3 three-pole, a-c solenoid contactor

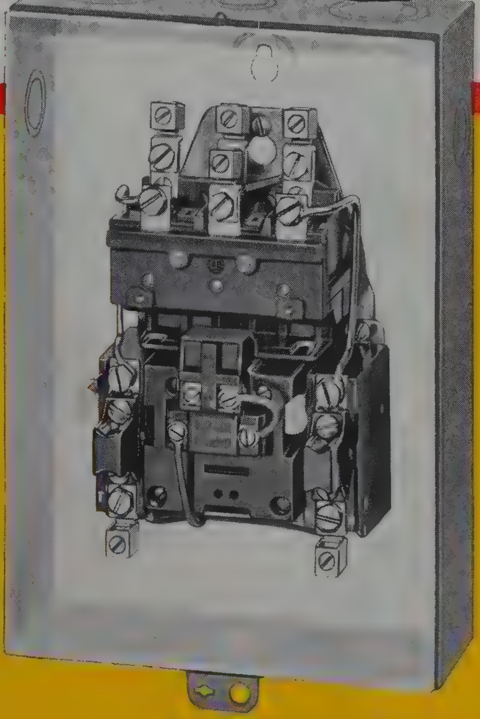
Pygmies in Size Giants in Performance—

the NEW Allen-Bradley Across-the-Line Starters!

This new line of across-the-line motor starters is the result of over 30 years of experience and leadership in the motor control field.

While retaining the simple solenoid principle—with only ONE moving part—these starters are completely new in every way. They are amazingly small in size—yet test after test has proved they will not only outperform but also outlast any starter now on the market. They are good for *many millions* of trouble free operations. All have scores of design refinements that make them easier to install and maintain. All are available in the smart new enclosures designed by Brooks Stevens. They make a beautiful addition to any machine or control installation.

You'll want to get the complete story about these truly revolutionary new across-the-line starters. Write for new Publication 6100.



BULLETIN 709

This popular across-the-line solenoid starter shows the new Size 2 construction. Note the white interior and generous wiring space. Bulletin 709 starters are available, in the new construction, in seven sizes—Sizes 00 to 5, with a maximum rating of 100 hp, 220 v; 200 hp, 440-550 v.

11-61-RM

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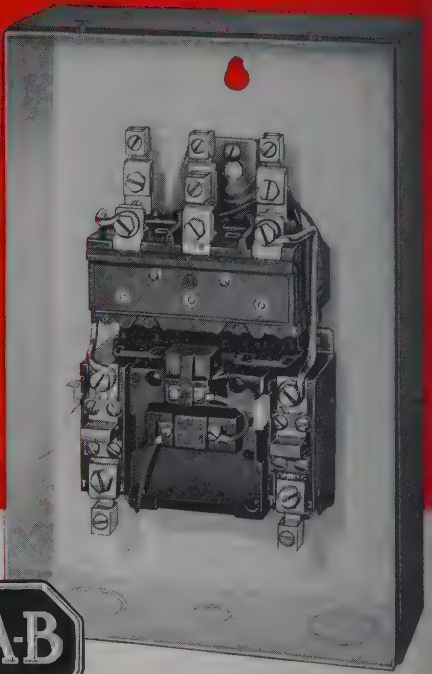
Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

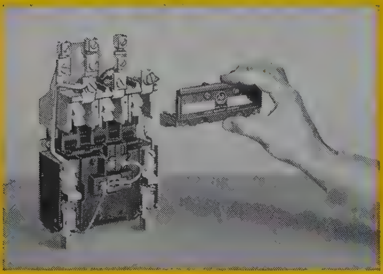
QUALITY MOTOR CONTROL

Features of the NEW Allen-Bradley starter line that are of value to you!

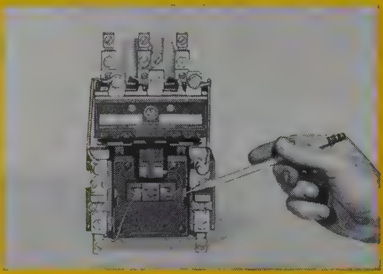


New Bulletin 709 Size 3 across-the-line motor starter. Note the generous space for wiring, accessible terminals, and white interior.

Every detail of the new Allen-Bradley motor starters has been designed to help make this the best line of motor control on the market. Remarkably small in size, each starter is a giant in performance. Being light in weight, these starters are easy to handle and a cinch to install. The generous wiring space, full front wiring, white interiors, and convenient knockouts make installation easy. The enclosure cover is firmly held with a quarter-turn fastener. All installation, inspection, and maintenance operations can be handled from the front—as shown in the illustrations below—without the use of special tools.



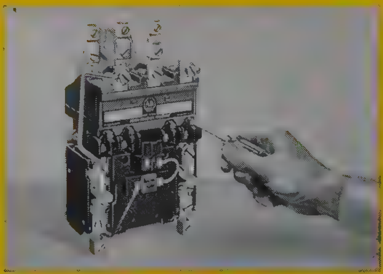
QUICK, EASY CONTACT INSPECTION—When the arc hood front cover is removed by loosening two captive screws, contacts are plainly visible from the front.



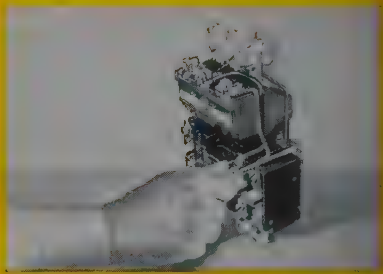
CONTACT POSITION INDICATED—Two slots in the coil cover show the position of the movable contact support—tell whether contacts are "closed" or "open."

CONTACTS EASILY REPLACED—Depress the spring slightly, and the movable contacts can be lifted out of the molded support and the new contacts slipped in.

COIL EASILY CHANGED—When the coil cover is removed, coil and magnet yoke can be lifted out from the front. They are impossible to replace incorrectly.



AUXILIARY CONTACTS EASILY ADDED to the front of the starter. Two extra auxiliaries can be added to Sizes 0, 1, and 2 starters, and four, to Sizes 3, 4, and 5.



A THIRD OVERLOAD RELAY CAN BE EASILY ADDED in the field, from the front of the starter. And the only tool needed is a common screwdriver.

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QUALITY MOTOR CONTROL

at intersection, nurses' stations, doctors' lounge, library, auditorium, nurses' dining room and at other locations shown on plans, there shall be a paging lamp annunciator. There shall also be enclosed therein a buzzer (or chime may be mounted adjacent to annunciator) with externally controlled cutoff switch. Adjacent to telephone switchboard operator there shall be a portable keyboard with three rows of keys for paging three persons, and provided with flexible cable with multi-plug and receptacle to a flush terminal cabinet mounted in wall. Operation of the buttons in the same row will light and flash corresponding numbers simultaneously in all lamp annunciators and pilot lights on the keyboard. When more than one person is to be paged, additional rows of buttons are operated and coded lamp signals appear in sequence and flash. System shall have a capacity of 120 calls using 3-2 digit code numbers, or 210 calls using 4-digit codes. Additional buttons shall be included to connect or disconnect the system and to operate the audible signals to obtain special attention. A control cabinet shall be installed in the machine room located in the basement for controlling the load and the sequence of calls and the flashing of the lamps. To extinguish the lamp signals, the reset button on the respective row is operated.

B. Central code transmitter, single-call system: In corridors, stockrooms, shops and other locations shown on the plans, there shall be a heavy-duty bar chime (single-stroke bell, buzzer, or single-projector vibration horn). Adjacent to telephone switchboard operator, there shall be an automatic motor-driven code transmitter with "on" and "off" switch and facilities for setting up a predetermined series of codes or impulses. Only one signal may be transmitted at one time but may be repeated as desired. (Capacity of transmitter determined by the number of persons to be paged.)

C. Voice, multiple-circuit system: In corridors, stockrooms, shipping room, shops and other locations shown on the plans, there shall be a loudspeaker. Adjacent to the telephone switchboard operator, there shall be a desk-type microphone with "press-to-talk" switch complete with flexible cable, plug and receptacle. In addition, there shall be a paging selector keyboard which shall enable the operator to connect each individual, group or riser of loudspeakers. A master switch shall be included to connect all loudspeakers simultane-

[Continued on page 236]

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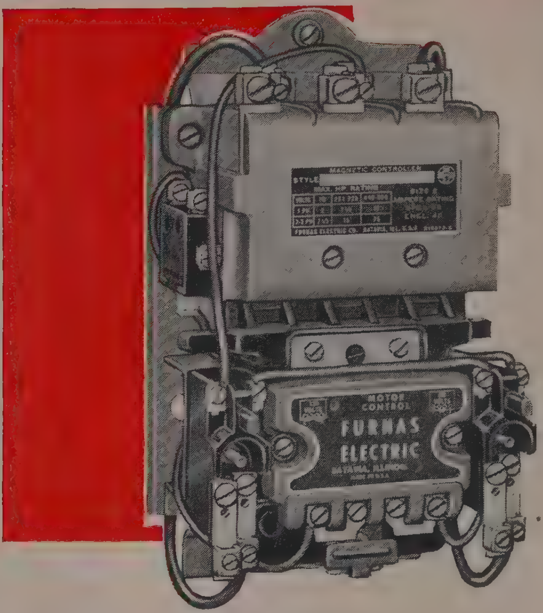
FORWARD
with FURNAS FIRSTS



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ously regardless of the position of the other switches.

11.43 Equipment

Aa. Install at each location shown a lamp annunciator with suitable mounting for the locality. Case shall be of heavy steel construction with hinged door. Single-face flush, and double-face, vertical wall bracket mounted annunciators shall have ten lamps each. Double-face ceiling or suspended horizontal mounting and double-face partition-mounted annunciators shall have two sets of ten lamps each. Size of indicators shall not be less than 2 in. high and shall have markings applied photographically or engraved on plastic sheet. Markings shall be 1 to 9 and 0. Buzzer shall be mounted in lower part of case and cutoff switch handle shall extend through bottom of case. (Where chime is mounted adjacent to annunciator, buzzer is omitted and two terminals are provided for extension.) Backbox to be provided by the manufacturer.

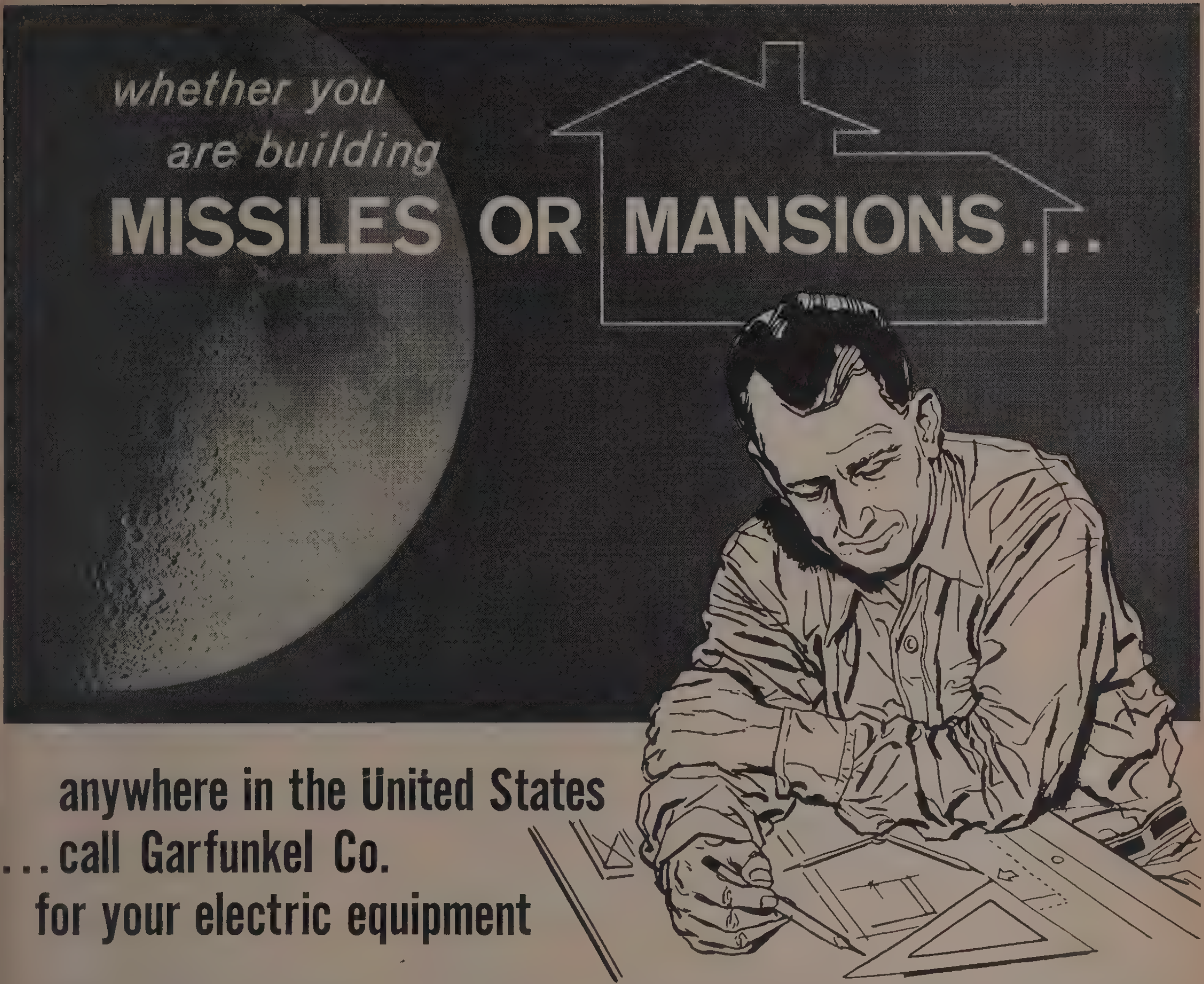
Ab. Install where shown a portable selector keyboard consisting of three rows of locking buttons or switches, each button in a row representing a single digit indication on the annunciators, and arranged parallel to each other. In addition, there shall be a "start" and a "stop" button, and an audible signal switch at the bottom of each vertical row. A flexible cable 10 ft long with multi-conductor separable plug and receptacle and flush terminal cabinet shall be provided for connection to the permanent wiring.

Ac. Install where shown a control panel enclosed in a surface steel cabinet with hinged door and lock with keys. This panel shall contain the necessary silent-mercury-contact relays, transformer for keyboard control, fuses, master switch and terminals.

Ba. Install where shown a heavy-duty single-stroke bar chime, single-stroke bell (with 4-, 6- or 10-in. gong) buzzer, or vibrating horns as indicated by symbol. These units shall be wound to operate in multiple on the maximum voltage of the system. These shall be designed to mount on standard outlet boxes.

Bb. Install where shown a synchronous motor-driven automatic code transmitter having a selector keyboard or mechanical arm for setting the transmitter to call desired person. Index card or sheet shall be provided thereon for inserting the names of the individuals. A flexible cord and terminal box shall be provided for connection to 115-volt, 60-cycle, trans-

[Continued on page 238]



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former and to connect to the signal circuit.

Bc. Install where shown a silent-mercury-contact or gravity-silver-contact relay or relays enclosed in surface steel cabinet with hinged door and connect with code transmitter. Relays shall be of sufficient size to carry the load of all signal devices.

Ca. Install where shown a permanent-magnet, dynamic-type loudspeaker single-face flush, surface-wall, double-face wall-bracket mounting or portable desk mounting as indicated by symbol. These speakers shall be of sufficient volume and size to be distinctly heard over the installation area.

Cb. Install where shown a portable-type adjustable desk-stand crystal microphone complete with flexible cable, plug and receptacle. A "press-to-talk" switch shall be provided on the microphone. (A floor-type switch may be supplied with connecting cord to free operator's hand.)

Cc. A selector keyboard shall be provided with the microphone consisting of a portable cabinet containing a heavy-duty switch for each individual, group or riser of loudspeakers and equipped with a flexible cable and terminal block in surface housing. A master switch shall also be provided below circuit switches.

Cd. Install where shown a voice paging amplifier equipped with volume control, tone control, power switch, protecting fuses, multi-tap output transformer and receptacle for microphone, enclosed in ventilated steel cabinet. This unit shall be of ample capacity to operate the entire system.

11.44 Terminal-Strip Cabinets

Install where shown on plans flush steel cabinets with hinged doors equipped with lock and keys. The terminal strips shall have sufficient pairs of terminals for all conductors, plus 10% spares. Terminal strips shall be mounted on a sheet of insulating material.

11.45 Wiring

All wiring shall be run in approved conduit in the same manner as for the lighting system. The wires shall be color-coded and rubber-covered. Feeder wires to control cabinets and relay cabinets shall be No. 12 B & S gauge. (A) Number of wires between the control cabinet or relay cabinet to annunciators: 11 without audible signals, and 12 with audible signals, with common-feeder wire No. 12 B & S

[Continued on page 240]

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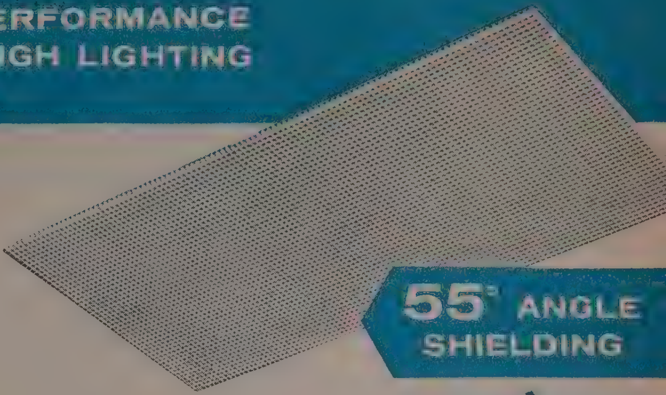
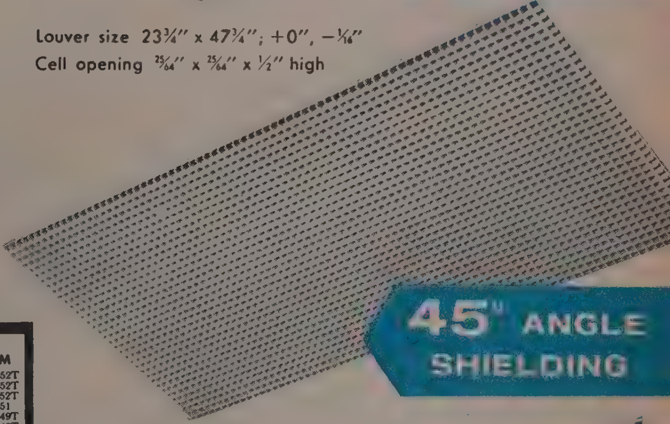


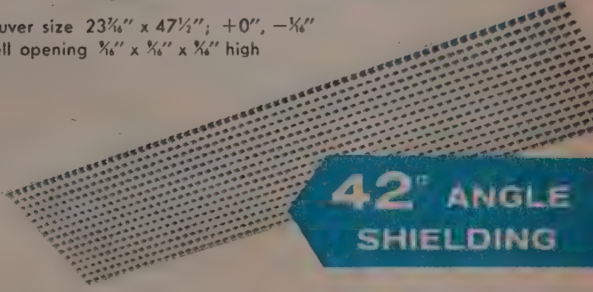
55° ANGLE SHIELDING

Louver size 23¾" x 47¾"; +0", −1/16"
Cell opening 25/64" x 25/64" x ½" high



45° ANGLE SHIELDING

Louver size 23 7/16" x 47½"; +0", −1/16"
Cell opening 9/16" x 9/16" x 9/16" high



42° ANGLE SHIELDING

Louver size 10¾" x 47¾"; +0", −1/16"
Cell opening 5/8" x 5/8" x 9/16" high

american plastic louvers

	Units	Formulation HF 77–1040	ASTM
MECHANICAL			
Tensile Strength	Lbs. per sq in.	6500–8000	D638–52T
Elongation at Break	Percent	1.8–2.4	D638–52T
Modulus of Elasticity	In tension lbs./sq.in.	4–5 x 10^5	D638–52T
Hardness	Rockwell	M70–80	D785–51
Flexural Strength	Lbs. per sq.in	9000–13,000	D790–49T
Deflection at Break	Inches	0 15–0 35	D790–49T
Impact Strength			
½" x ½" Notched	Izod.ft lbs per in of notch	0 25–0 35	D256–47T
½" x ⅛" Gate End Notched	Izod.ft lbs. per in of notch	0 60–0 70	D256–47T
½" x ⅛" Dead End Notched	Izod.ft.lbs. per in. of notch	0.30–0 40	D256–47T
Machining	— — —	Average	
THERMAL			
Thermal Expansion	In /in per °C	6–8 x 10^{-5}	D696–44
Heat Distortion	°F at 264 psi	183–191	D648–45T
	% at 4000 psi at 50°C.	0 8–1.0	D621–51
Deformation Under Load	% at 2000 psi at 50°C	— — —	D621–51
OPTICAL			
Light Transmission # 1040 Pigmentation			
0 060" thick	Percent Transmission @550 mu	52	
0 100" thick	" " " "	38	
0 150" thick	" " " "	29	
PHYSICAL			
Specific Gravity		1 04–1.06	D792–50
Moisture Absorption	Percent	0 03–0 04	D570–42
Burning Rate (0 050" thick)	In./min.	1	D635–44
ELECTRICAL			
Dissipation Factor	10^6 cycles	0001– 0005	D150–47T
Dielectric Constant	10^6 cycles	2 45–2.65	D150–47T
Dielectric Strength	Volts/Mil. ⅛" thick	400	D149–44
Volume Resistivity	Ohm/cm	10[illegible]	D257–52T

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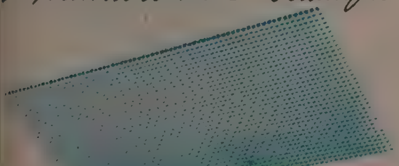

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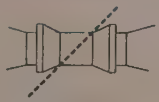
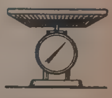
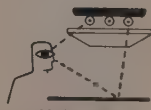


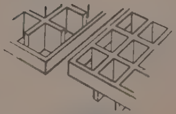
IDEAL SHIELDING



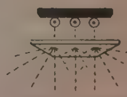
LIGHTER WEIGHT



LOW SURFACE BRIGHTNESS



INTERLOCKING



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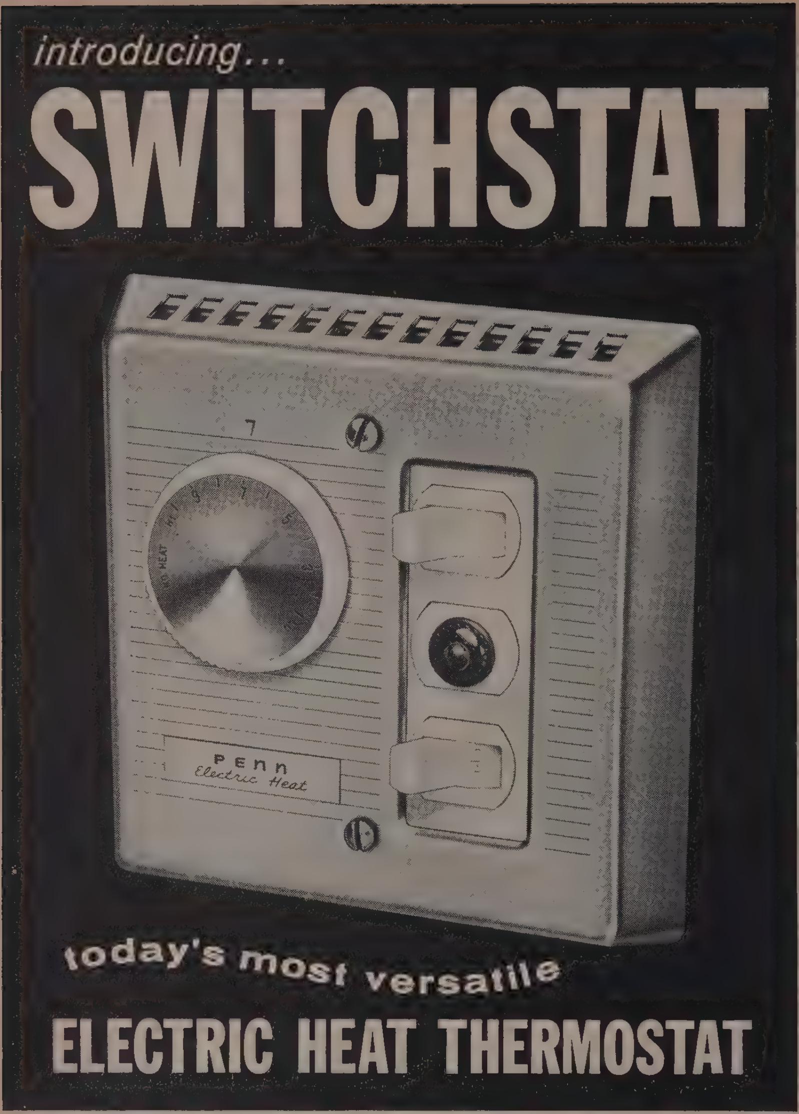

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For bathrooms, kitchens, recreation rooms, and any place you need a room thermostat *combined in one mounting* with interchangeable switches or other devices . . . use the all-new Penn *Switchstat.*

Simple to install and easy to wire, *Switchstat* is beautifully designed to harmonize with any room decor. It offers more convenience than any other electric heat thermostat. You can easily install one, two or three wall switches . . . pilot light . . . convenience outlet . . . or any other combination of interchangeable wiring devices all in one attractive unit. Try it on your next job, you'll discover *Switchstat's* many advantages. Ask your wholesaler or write to Penn.

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EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.
AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING,
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gauge and lamp and audible-signal section wires, No. 14 B & S gauge. (B) Number of wires between the keyboard and the control panel: 15 wires without audible signals, and 16 with audible signals, No. 16 B & S gauge. (C) Number of wires between the relay cabinet and sounding devices: two not smaller than No. 14 B & S gauge. (D) Number of wires from amplifier to microphone: one No. 18 B & S gauge rubber-covered shielded twisted pair. Number of wires from selector keyboard to loudspeakers: one No. 18 B & S gauge rubber-covered twisted pair for each separate section of loudspeakers. The amplifier requires one pair of No. 14 B & S gauge wires from the source of supply.

11.5 Fire-Alarm Systems

Note: The National Fire Protection Association has a specific code for fire-alarm systems. This NFPA Code 72 is entitled "Standards for the Installation, Maintenance and Use of Proprietory, Auxiliary, Remote Station and Local Protective Signaling Systems, including Local or Isolated System for Watchman, Fire Alarm and Supervisory Service." It is recommended that those writing fire-alarm systems specifications obtain a copy of NFPA Code 72 from the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., and become familiar with its requirements. The specifications as described below follow the general requirements of NFPA Code 72 and it is recommended that the specifications state "the system shall meet the requirements of NFPA Code 72," and be listed by the Underwriters' Laboratories.

A. Non-coded, closed-circuit, supervised.

B. Master-coded, closed-circuit, supervised.

C. Coded, closed-circuit, supervised.

D. Coded pre-signal, closed-circuit, supervised.

E. Coded auxiliarized, municipal connection.

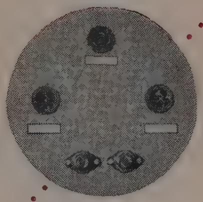
F. Non-coded, automatic, closed-circuit, supervised.

G. Zoned, automatic, low-voltage, closed-circuit, supervised.

11.51 General

Furnish and install a (trade name and/or number) fire-alarm system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manu-

[Continued on page 242]



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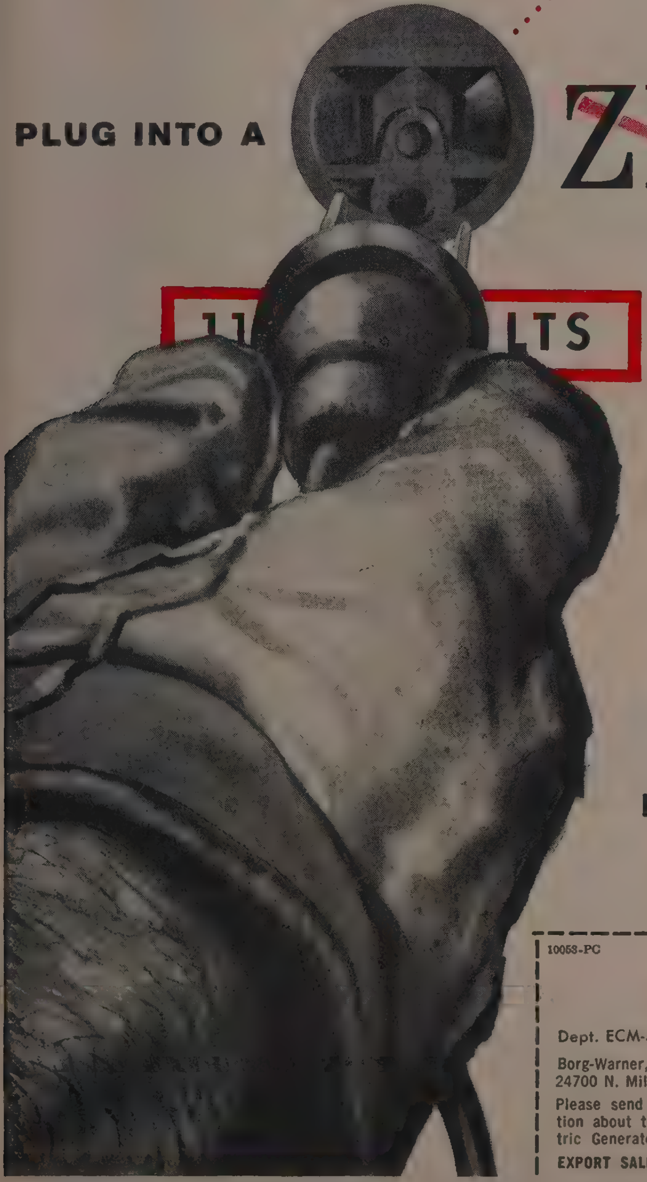

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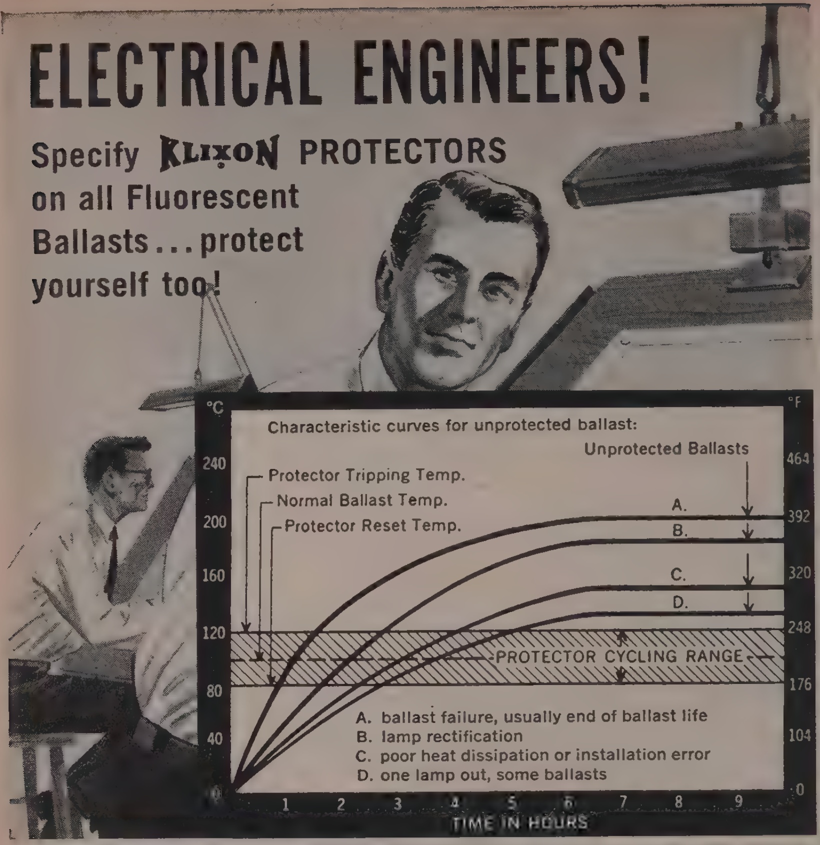

In the installation and operation of fluorescent fixtures (see chart) you can protect your own reputation and give your client important extra benefits at low, low cost . . . simply SPECIFY BALLASTS WITH KLIXON PROTECTORS!

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- Ballasts and fixtures that operate within U/L temperature limits . . . positive protection against overtemperature, overcurrent, or both.
- Cool running installations . . . rapid response against overheat allows correction while contractor is still on job.
- Maximum ballast life . . . external faults can not cause dangerous overheating. When corrected, ballast operates normally again. An internal fault signals need for ballast replacement . . . with protector keeping temperature at a safe level until this is convenient.
- No dripping compound, fires or violent failures at end of ballast life.

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Ballasts equipped with KLIXON Protectors can be supplied to your fixture manufacturer by all six leading makers of ballasts. Simply use specifications shown here. Write for full engineering details.

KLIXON ® PROTECTOR (actual size)

USE THIS KLIXON PROTECTION SPECIFICATION

"Ballast shall be thermally protected against overheating by a built-in automatic reset overheat protector sensitive to both winding temperatures and current which will prevent winding temperatures from exceeding 120°C with the exception that the peak temperatures in the first few cycles may exceed this. The protector must allow the winding temperatures to reach 105°C minimum under normal conditions in a 40°C ambient without opening the circuit to the primary winding, and after opening shall not reclose above 85°C. Fixtures must be so designed that ballast coil temperatures shall not exceed the U/L limit of 105°C in a 40°C ambient."

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A CORPORATE DIVISION OF
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facturer's specifications and left in first-class operating condition.

11.52 Operation

A. Non-coded, closed-circuit, supervised system: At each stairway, exit, and other locations shown on plans, there shall be a non-coded fire-alarm station. At each location where shown, there shall be a bell (or horn). Operating any station shall cause all sounding devices to operate continuously until the fire-alarm station has been restored to normal. It shall also be possible for those in authority to transmit a test signal from any station. The stations and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power supply source or a break or a ground fault of its installation wiring circuits.

B. Master-coded, closed-circuit, supervised system: At each stairway, exit and other locations shown on plans, there shall be a non-coded fire-alarm station. At each location shown, there shall be a bell (or horn). Operating any station shall cause the master-code mechanism on the control panel to transmit a common code (such as 4-4) on all sounding devices in the system. It shall also be possible for those in authority to transmit a test signal from any station by opening the front cover by means of a key. The station and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power supply source or a break or ground fault of its installation wiring circuits.

C. Coded, closed-circuit, supervised systems: At each stairway, exit and other locations shown on the plans, there shall be a coded fire-alarm station. At each location shown there shall be a bell (or horn). Pulling and releasing the lever of any station shall cause the code number of that station to be sounded four times on all signal devices in the system. The stations and the sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. It shall be possible to make a single tap test, and a silent running test on any station by operating an enclosed lever or by inserting a key into an

[Continued on page 244]

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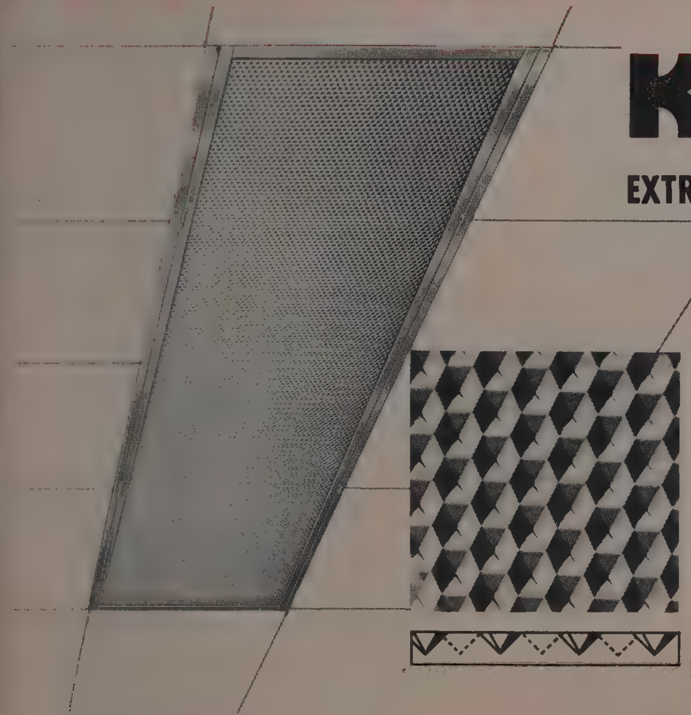
a complete and growing line of lighting panels • easy to specify • easy to install



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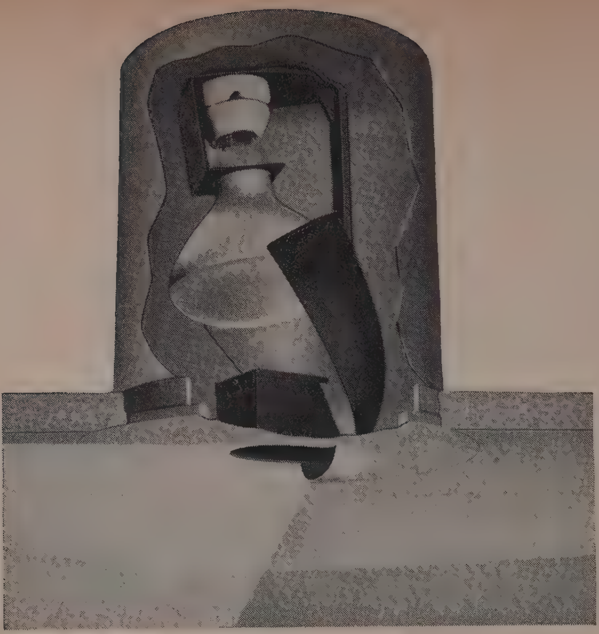

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opening provided therefore and turning it in either of two directions. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power-supply source or a break or ground fault of its installation wiring circuit.

D. Coded pre-signal, closed-circuit, supervised system: At each stairway, exit and other location shown on plans, there shall be a coded pre-signal fire-alarm station. At each location there shall be a general-alarm bell or a pre-signal bell or chime as indicated. Pulling and releasing the lever of the station shall cause the code number of that station to be sounded four times on all pre-signal devices only. Inserting a special key in an opening of any station and then pulling and releasing the lever shall cause the code number of that station to sound on all signal devices, both pre-signal and general alarm throughout the system. The station and sounding devices shall be connected to a control panel which shall permit a small supervisory current to pass through the entire system. It shall be possible to make a single-tap test, and a silent-tuning test on any station by operating an enclosed lever, or by inserting a key into an opening provided therefor, and turning it in either of two directions. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main supply source or a break or a ground fault of its installation wiring circuit.

E. Coded, auxiliarized, municipal-connected system: At each stairway, exit and other locations shown on plans, there shall be a coded, auxiliarized fire-alarm station. At each location, there shall be a bell (or horn). Pulling and releasing the lever of the station shall cause the code number of that station to be sounded on all signal devices in the system four times and transmit the alarm simultaneously to the City Fire Department by tripping an auxiliarized City Master Fire-Alarm Station on the premises. A test of the system and a silent-running test of the mechanism in the stations may be conducted from any station without sending an alarm to the City Fire Department. The stations and the sounding devices shall be connected to a control panel, which shall permit a small supervisory current to pass through the entire system. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power-supply source or a

[Continued on page 246]

from the Ground UP . . .

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DUAL-GRIP ENTRANCE HEADS

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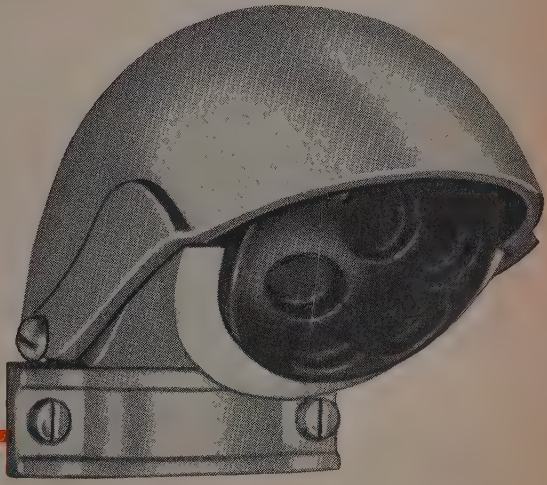

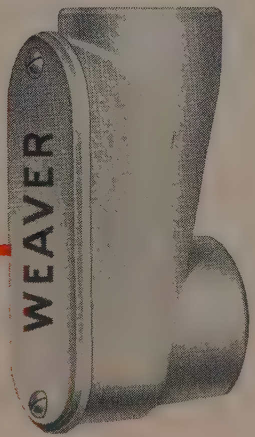

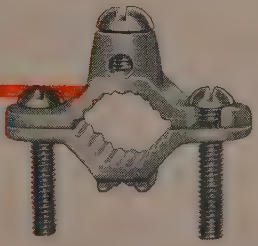

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break or a ground fault in its installation wiring circuit.

F. Non-coded, automatic, closed-circuit, supervised system: In all rooms, corridors, closets, shops, storerooms, attic and other locations shown on plans, there shall be mounted on the ceilings, detectors, properly spaced and installed to provide maximum protection in accordance with the Underwriters' rated spacings of the detectors to be used. At each location there shall be a bell (or horn) and at least one non-coded manual fire-alarm station per floor. The automatic operation of any detector or the manual operation of any station shall cause all sounding devices to operate continuously throughout the system. The detectors, manual stations and sounding devices shall be connected to a control panel, which shall permit a small supervisory current to pass through the entire wiring of the system. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power supply source or a break or a ground fault of its installation wiring circuits. The trouble bell shall include a transfer switch and a pilot light mounted on the control panel.

G. Zoned, automatic, low-voltage, closed-circuit, supervised system: In all rooms, corridors, closets, shops, storerooms, attic and other locations shown on plans there shall be mounted on the ceilings, detectors properly spaced and installed to provide maximum protection in accordance with the Underwriters' rated spacings of the detectors used. At each location shown, there shall be a bell (size and number of bells so located that they may be heard by all occupants of the building) and at least one non-coded manual fire-alarm station per floor. The detectors and their associated manual stations shall be wired in zones so as to indicate at the control panel the location (by zone) of the fire. In addition, the operation of any detector or a manual fire-alarm station shall cause all sounding devices to operate continuously until the operated detector or manual station has been restored to normal and a reset button in the control panel has been pressed. The detectors, manual stations and sounding devices shall be wired and connected to a control panel, which shall permit a small supervisory current to feed through to the detectors and manual stations. A trouble bell shall also be provided and shall sound continuously in the event of failure of the main power supply source, or a

[Continued on page 248]

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PLEXIGLAS provides the efficient transmission and diffusion of light that results in a 300-footcandle level of shadowless illumination in the area. The diffusers are strong, rigid and light in weight, with easily cleaned smooth surfaces. In addition, PLEXIGLAS is highly resistant to breakage and notable for its freedom from discoloration after years of exposure to fluorescent light. These are the advantages that have made PLEXIGLAS the word for *quality* in all types of commercial and industrial lighting installations.

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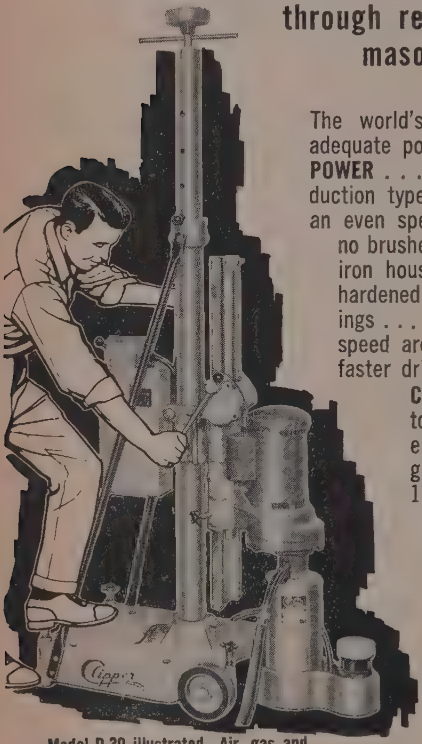
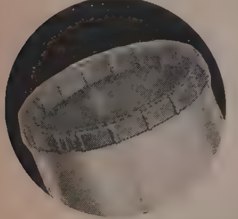


The world's first core drill designed with adequate power at a constant speed.

POWER . . . specially designed 3 h.p. G.E. induction type motor gives maximum power at an even speed . . . lifetime lubricated . . . no brushes to wear out. Mounted on a cast iron housing with extra large, heavy duty hardened steel gears . . . anti-friction bearings . . . free from maintenance. Power and speed are essential for longer bit life and faster drilling.

CONSTANT SPEED . . . it is essential to vary the speed when using different sized bits. Clipper core drill gives you a choice of 300, 800, 1500 R.P.M.—a must when drilling through reinforced concrete. Don't be misled—adequate power and speed are necessary, for they give you longer bit life and faster drilling. Compare Clipper's drill with the limited duty hand drill motor that has insufficient power, has lightweight housing and gears, and slows down under load.

Model D-30 illustrated. Air, gas and electric models available—from $335.



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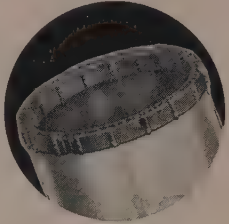

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break of the detector and manual station installation wiring circuit. The trouble signal shall include a transfer switch and a pilot light mounted on the control panel.

11.53 Equipment

Aa. Install where shown a flush (or surface) non-coded (1) breakglass or (2) non-breakglass manual firealarm station, with hinged front door arranged for making tests without breaking glass, and for easy replacement of the glass when broken. Flush station shall mount on standard outlet box with single-gang cover. (Surface stations are provided with backcasting by manufacturer.)

Ab. Install where shown on plans an underdome vibrating bell (4-, 6-, or 10-in. size), or heavy-duty type vibrating horn of the grille type as indicated by symbol. Note: Size and number of signals to be located so that they may be heard by all occupants of the building.

Ac. Install where shown a closed-circuit fire-alarm control panel in surface (or flush) wass-type steel cabinet equipped with hinged door with lock and keys. Panel shall contain all necessary relays, meter, resistances, thermal cut-out, terminals and fuses for the control and supervision of the system. Panel shall operate on 115/230-volt, 60-cycle, 3-wire supply current. Panel shall contain number of bell and station circuits required. A trouble bell shall be provided for external connection.

Ba. (Same as paragraph Aa.)

Bb. Install where shown an underdome single-stroke plunger-type bell (4-, 6-, or 10-in. size) chime or heavy-duty vibrating horn of the grille type as indicated by symbol. Note: Size and number of signals to be located so that they may be heard by all occupants of the building.

Bc. Install where shown a closed-circuit fire-alarm control panel of the master-coded type in surface (or flush) wall-type steel cabinet equipped with hinged doors with lock and keys. Panel shall contain all necessary relays, meter, resistances, thermal cutout, master code movement, terminals and fuses for the control and supervision of the system. Panels shall operate on 115/230-volt, 60-cycle supply current. Panel shall contain number of bell and station circuits required. A trouble bell shall be provided for external connection.

Ca. Install where shown a semi-flush (or surface) coded, pull lever,

[Continued on page 250]

Architect: Holabird and Root
General Contractor: E. H. Marhoefer Jr. Co.
Electrical Contractor: Electrical Contractors, Inc.

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and the Silent Guardian of its entire wiring system is

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The conduit used: Exclusively Nikoh . . . both thinwall and rigid.

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from a compact light source, it's the
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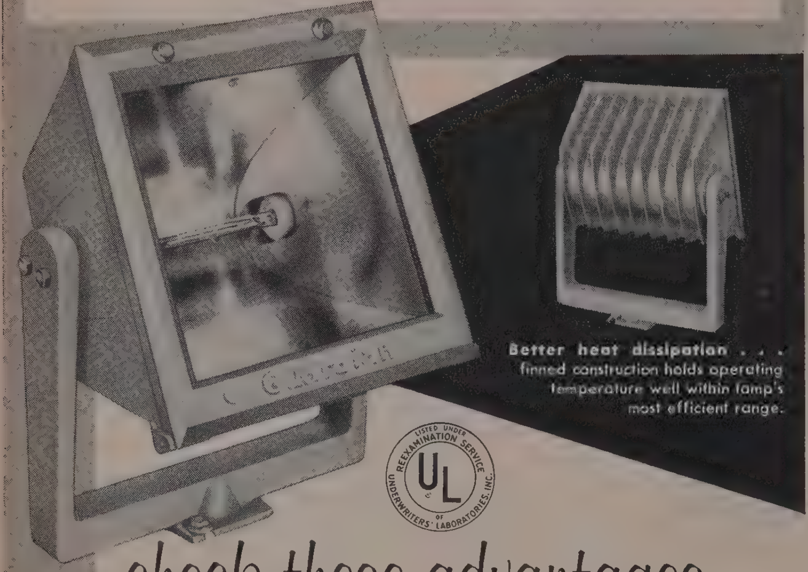
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four-round (1) non-breakglass or (2) breakglass fire-alarm station. The station shall be provided with a code wheel, coded as required. Facilities shall be included for making a single-tap test and silent-running test. Backbox to be provided by the manufacturer.

Cb. (Same as paragraph Bb.)

Cc. (Same as paragraph Ac.)

Da. Install where shown a semi-flush (or surface) pre-signal, pull lever four-round (1) non-breakglass or (2) breakglass fire-alarm station. Station shall be provided with a code wheel, coded as required. A lock and key shall be provided on the cover for transmitting a general alarm. Facilities shall be included for making a single-tap test and silent-running test with key or lever. Backbox for the installation to be provided by manufacturer.

Db. (Same as paragraph Bb.)

Dc. (Same as paragraph Ac.)

Ea. Install where shown a semi-flush (or surface) pull lever, four-round (1) non-breakglass or (2) breakglass coded-type fire-alarm station. Station shall be provided with a code wheel coded as required with municipal-alarm interlocking contacts for operating the auxiliarized City Master Fire-Alarm Station. The station shall be arranged to permit fire drills without sending alarms to the municipal system. Backbox to be provided by the manufacturer.

Eb. (Same as paragraph Bb.)

Ec. Install where shown a closed-circuit fire-alarm system control panel in surface (or flush) wall-type steel cabinet equipped with hinged door with lock and keys. Panel shall contain all necessary relays, meters, resistances, thermal cutout, terminals and fuses for the control and supervision of the interior system, and separate terminals for connection to the municipal system. Panel shall operate on 115/230-volt, 60-cycle, 3-wire supply current. Panel shall contain number of bell and station circuits required. The trouble bell shall be provided for external connection, together with trouble pilot light and silencing switch.

Fa. Install where shown thermostatic detectors of the rate-of-rise and/or fixed-temperature type with open-circuit contacts and mounted on round outlet boxes and covers for operation on 136° F (or 190° F).

Fb. (Same as paragraph Aa.)

Fc. (Same as paragraph Ab.)

Fd. (Same as paragraph Ac.)

Ga. (Same as paragraph Fa.)

Gb. (Same as paragraph Aa.)

[Continued on page 252]

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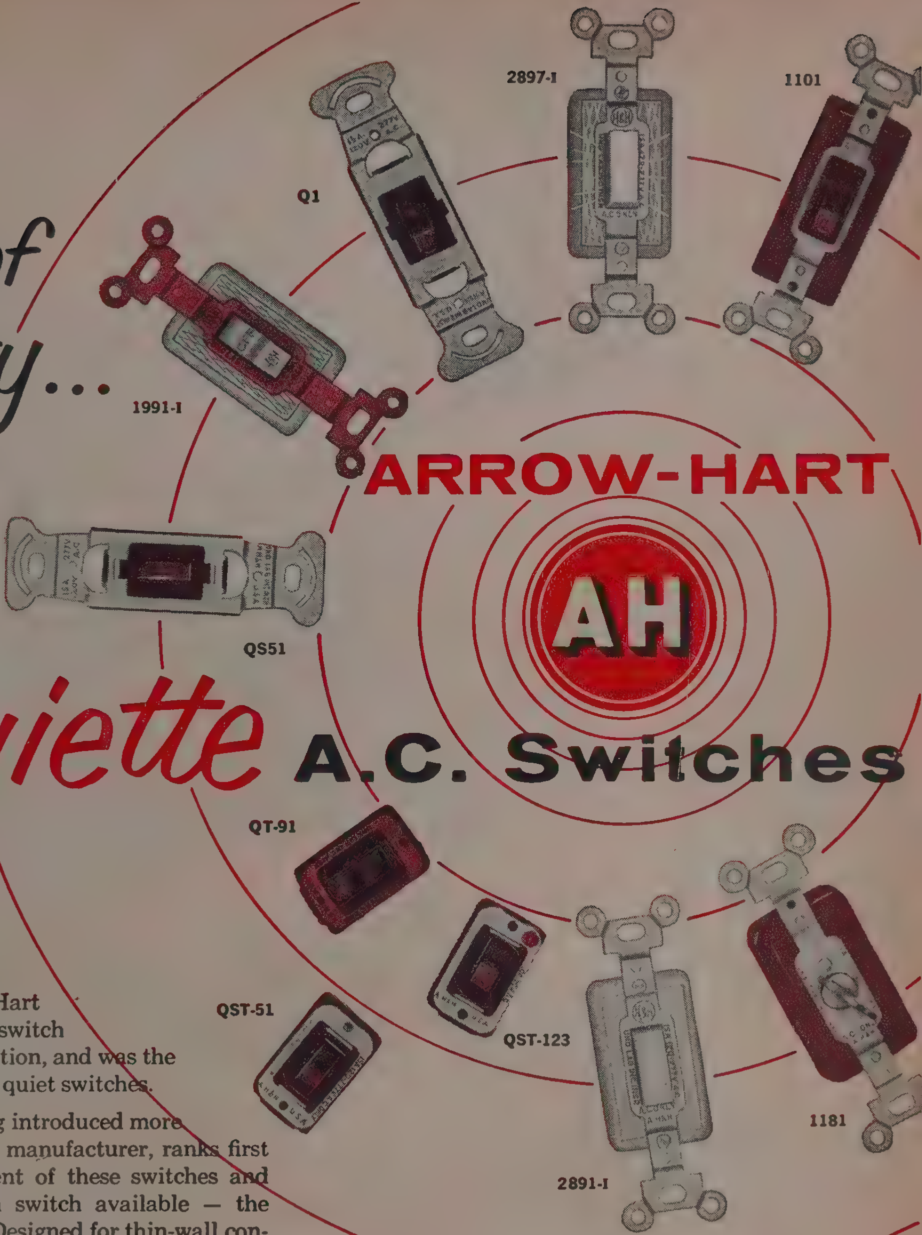

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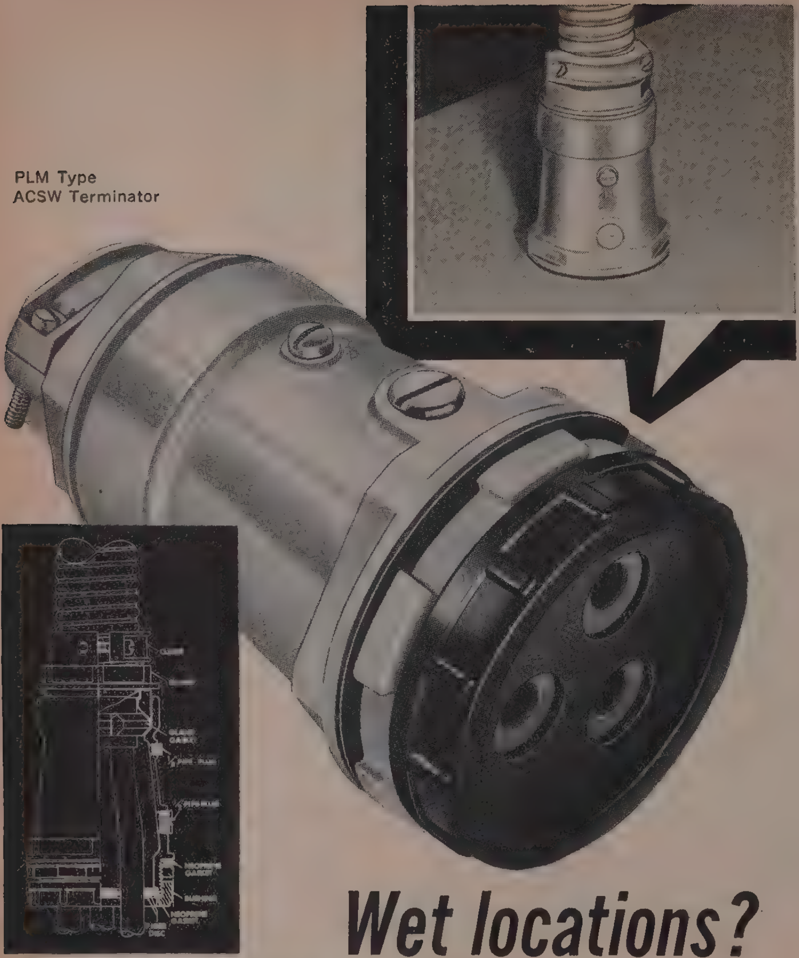

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Gc. (Same as paragraph Ab.)

Gd. Install where shown a closed-circuit fire-alarm control panel in surface (or flush) wall-type steel cabinet equipped with hinged door with lock and key. On the door there shall be as many pilot lamps as there are zones and a trouble lamp and an alarm lamp. On the fire-alarm control panel, there shall be mounted the necessary relays, trouble bells, with cutoff switch and signal reset buttons and wiring terminals. The panel shall be operated from the secondaries of two 100-watt signaling transformers (one transformer to operate the system and the other to operate the trouble bell). The primaries of these transformers shall be connected to a 115/230-volt, 3-wire, 60-cycle supply current.

11.54 Wiring

Service connection to the system shall be made on the house side of and as near as possible to the meter. All interior wiring shall be in strict accordance with NFPA Codes 70 and 72 and all local electrical codes applying. Size and number of wires shall be in accordance with wiring diagram supplied by manufacturer of fire alarm system.

11.6 Electric Clock Systems

A. Synchronous-wired dual-motored clocks, central control system.

B. Master time control with synchronous-wired clocks, system.

C. Master time control with minute-impulse-wired clocks system.

D. Electronic-controlled synchronous clocks, system.

11.61 General

Furnish and install a (trade name and/or number) electric clock system as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left in first-class operating condition.

11.62 Operation

A. Synchronous-wired dual-motored clocks, central control system. Each clock of the system is equipped with two motors. During normal operation, the "normal" motor in each clock operates at normal rate. When a power interruption occurs, the clocks of the system stop and when power returns, all clocks start again automatically,

[Continued on page 254]

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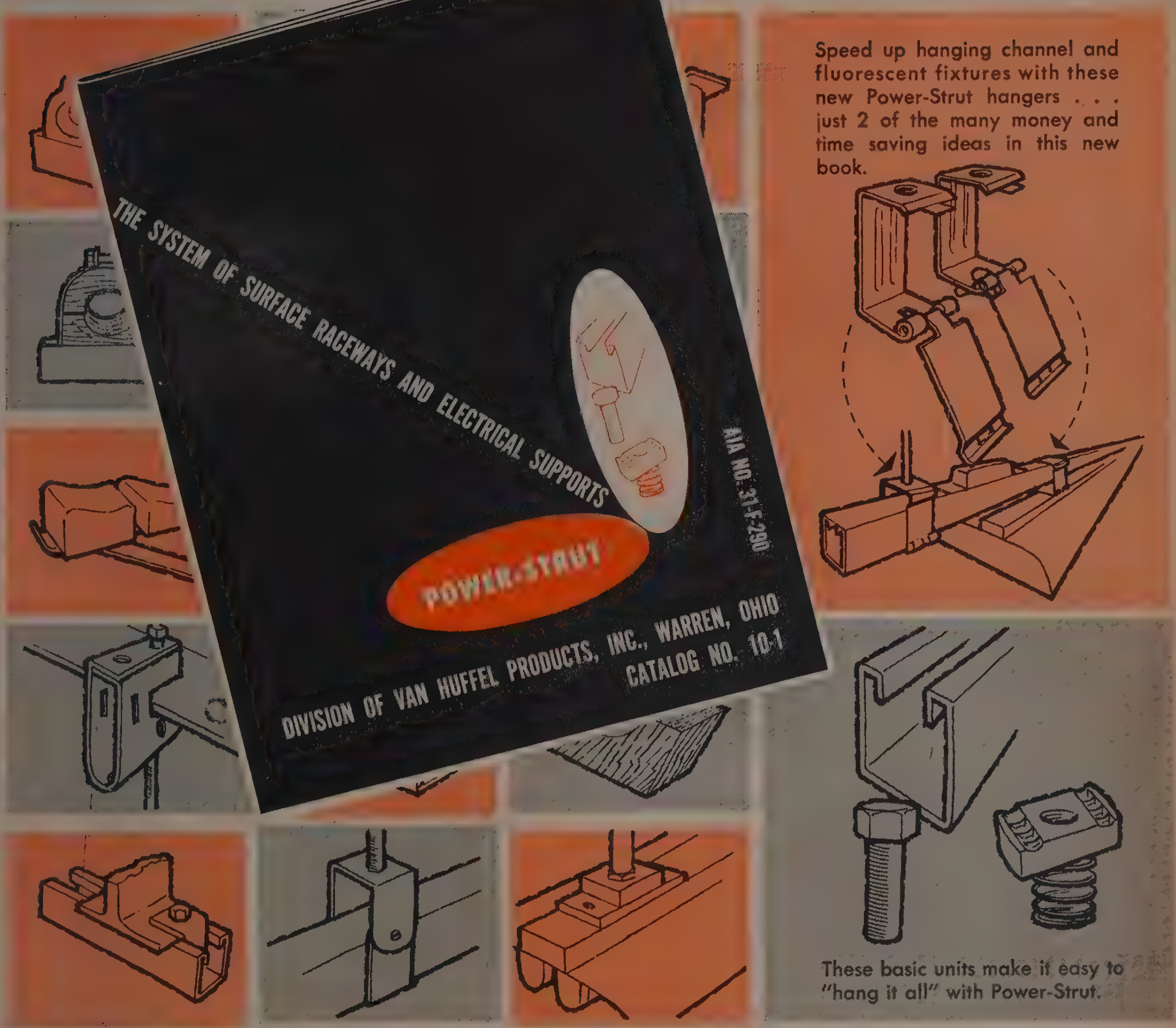
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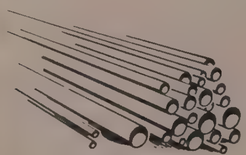

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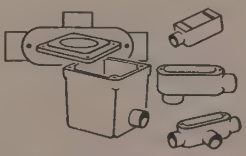

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but are slow to the extent of the power interruption. The second or "reset" motor in each clock is used to advance the clocks at an accelerated rate until correct time is reached. The reset motors may also be used to advance all clocks from Standard to Daylight Saving Time. Two types of central control are available, i. e., (1) switch reset and (2) automatic reset. Note: The switch reset control is recommended where power supply is reliable with infrequent interruption and the automatic control should be used where power supply is subject to frequent interruption and/or it is desirable to have several clocks running continuously regardless of power interruption. (1) The switch reset control shall be equipped with a red pilot lamp to indicate when there has been a power interruption and with two key switches, one to advance the clocks and the other to stop the clocks (as would be required to change the system from Daylight Saving to Standard Time or for repairs to the system). (2) The automatic reset control automatically advances all clocks to correct time upon restoration of power after a power interruption (up to 12 hours), and is equipped with reserve power to operate several clocks during power interruptions. The control is also equipped with switches for making time changes.

B. Master time control with synchronous-wired clocks, system. Each clock of the system is equipped with a synchronous motor and correction mechanism and is individually checked with the master time control once each hour and once each 12 hours. In the event of power failure, the clocks will stop but upon power restoration will be corrected at a pre-selected minute within the hour for power failures of less than one hour duration and at a pre-selected hour for duration, and at a pre-selected hour will be corrected for power failures up to 12 hours duration.

C. Master time control with minute-impulse-wired clocks, system. Each clock of the system shall receive an impulse from the master time control, once a minute which shall advance the clocks one minute. Each hour, rapid impulses are emitted from the master control to provide automatic hourly supervision of the clocks, and these impulses shall also restore the clocks to correct time upon power being restored after a power interruption.

D. Electronic-controlled synchronous clocks, system. Each clock is synchronous motor-driven and is wired

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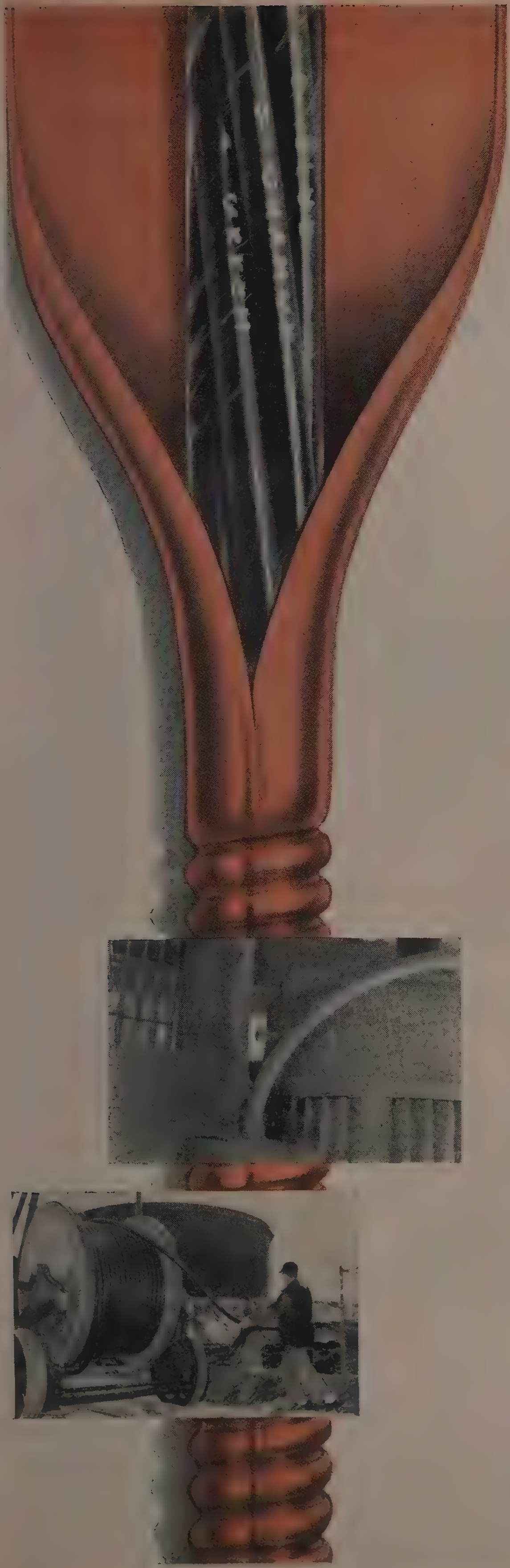

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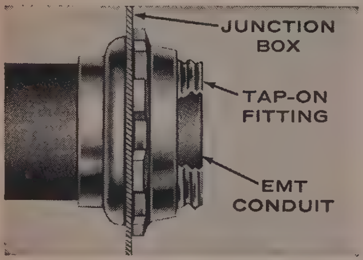

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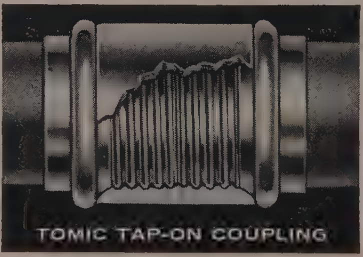

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to a 115-volt ac source. The clocks are individually checked for agreement with the master time control once each hour by a carrier-current pulse which is superimposed on the lighting bus or main distribution by transmitting equipment controlled and operated in conjunction with the electronic master time control. The clocks are equipped with a correction mechanism and an electronic signal receiver, and when varying from system time because of power failure up to 12 hours slow, will be corrected at a pre-selected minute within the hour for power failures of less than one hour duration and at a pre-selected hour for power failures of more than one hour.

11.63 Equipment

Aa. In a central location, install (1) a switch reset control unit, consisting of power-interruption pilot lamp, in-indicator relay and two key-type switches mounted on a 2-gang subplate with stainless-steel faceplate for flush mounting. The faceplate shall be engraved to identify the one switch as "Advance" and the other as "Off." (2) Automatic reset control complete with power unit for automatic correction of the system clocks after power interruptions up to 12 hours duration and with manual switches to make time changes. This control shall be furnished in flush (or surface) steel cabinet with hinged door with lock and key.

Ab. Install in rooms as indicated on the plans flush (or surface) clocks having an 8-, 12-, 15- or 18-in. dial with metal case with convex crystal glass, black hour and minute hands and red sweep second hand. In the corridors, install double-face clocks either ceiling- or wall-mounted (as specified) having 8-, 12-, 15-, or 18-in. dials with metal cases and convex crystal glass. In those locations where the crystal is subject to damage, such as in gymnasiums, the crystal shall be furnished with shatterproof glass for protection.

Ba. In a central location, install a synchronous motor-driven self-regulating master time control having reserve power to automatically correct all the clocks in the system to correct time after a power interruption of up to 12 hours duration. The control shall also automatically correct any individual clock for fast or slow operation once each hour and, in addition, shall provide for the automatic correction of any individual clock or group of

[Continued on page 258]

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clocks when slow up to 12 hours. The control unit shall be housed in a metal case flush (or surface) with pilot clock.

Bb. Same as Ab.

Ca. In a central location, install a synchronous motor-driven self-regulating master time control with necessary power equipment to send an impulse once a minute to all clocks in the system. The control shall also automatically correct all clocks in the system to correct time after a power interruption of up to 12 hours duration and, once each hour correct any individual clock for fast or slow operation. The entire unit shall be housed in a metal case flush (or surface) with pilot clock.

Cb. Same as Ab, except without sweep second hand.

Da. Same as Ba.

Db. Install as indicated on the plans the necessary transmitting units complete with power transformer, tubes, relays and terminal strips, which shall be operated by the master time control (Da) which shall cause a carrier-frequency pulse to be superimposed on the existing ac lighting sources. This pulse shall be received by an electronic receiver built into the individual indicating clocks. Determining capacity of the transmitter equipment shall be the responsibility of the equipment manufacturer.

Dc. Same as Ab.

11.64 Operating Current

The system shall operate from the 115-volt, 60-cycle lighting supply.

11.65 Wiring

All wiring shall be of the approved type as used for electric light and power wiring and shall meet the requirements of national, state and local electric codes. The size and number of wires shall be as specified by the manufacturer of the clock system.

11.7 Program Signal System

Note: In many applications, such as in schools, it is customary to have both a clock and program signal system; whereas, other applications, such as a small factory may require only a program signal system. Some manufacturers build the program control and the clock control into the same unit when the two systems are required; whereas, other manufacturers use separate physical units for the two functions. Various designs and sizes (according to the number of different program schedules required) of pro-

[Continued on page 260]

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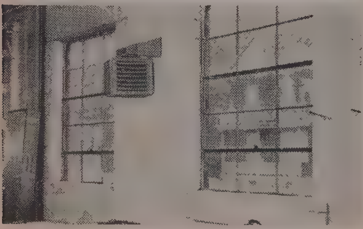

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gram instruments are available. The specifying agent should determine the number of different program schedules actually required for the specific installation at hand as cost of the program instruments varies accordingly. For example, a small factory or primary school would normally only require the program instrument to have one program circuit since all signals of the building would sound on the same schedule; whereas, a large office building or high school might require four, six or more, different program schedules. Program instruments vary by manufacturer as to the method in which the program schedule is set up and changed—some complicated, requiring the services of the manufacturer; others simpler which can be done by the owner. The specifying agent should, therefore, examine the various types available and select the type(s) and/or manufacturer(s) which he feels provides ease in changing the program schedule since many applications, such as schools require occasional changes in schedules. The following specifications do not attempt to describe the construction and design of all the available makes, they merely outline basic features and operation. When both a clock and program signal system are required, it should be determined that the manufacturer of the clock system (i. e., A, B, C or D) to be specified has available the type of program instrument desired or vice versa, as the same manufacturer should furnish equipment for both systems since they should have one central control.

11.71 General

Furnish and install a (trade name and/or number) program instrument as manufactured by (name of manufacturer) and described in these specifications and indicated on wiring plans. The system to be installed in accordance with the manufacturer's specifications and left in first-class operating condition according to the specifications.

11.72 Operation

The program instrument shall automatically control the operation of a group or groups of signals according to the desired program schedule. It shall be able to operate the signals, any minute during the 24-hour day, 7-day week. The program schedule may be set so that the signals connected to each circuit are independ-

[Continued on page 262]

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Variety of Construction Types . . . Mears circuit breakers are manufactured to special order for many of the nation's independent switchboard builders in **Fixed Switchboard** mountings, **Plug-In** mountings and **Drawout.**

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13725 S. W. Millikan Way • Beaverton, Oregon

ently omitted on any day or days during the week. (Example: Most installations do not require the signals be operated on Saturday or Sunday.) Provisions shall be provided for the manual operation and for cutoff of the signals wired on the same circuit for special day schedules without disturbing the program settings or the running of the program instrument. Means shall be provided for adjusting the duration of sounding the signals. Program instruments having a capacity of more than one circuit (each group of signals which are to operate on an individual program schedule are wired to a separate circuit terminating at the program instrument) shall provide two adjustable signal durations so that the exterior signals which are wired on one circuit may be sounded for a longer duration than the interior signals which are wired to the other circuits. When the program instrument is installed with a clock system, the same central-control equipment shall be used to control both the clock system and the program instrument.

11.73 Equipment

A. Install where shown a flush- (or surface) mounted program instrument for automatically operating signals according to a predetermined schedule of minute intervals of a 24-hour day, 7-day week. The instruments shall have a capacity of . . . circuits, (specify the number of circuits which is determined by the number of groups of signals wired independently to the program instrument so that each group may operate on its own schedule) each circuit to have its own program schedule. The instrument shall accommodate a schedule that eliminates the operation of the signals, independently by circuit, on any day or days during the week, for use when required. Manufacturer's installation instructions should be carefully followed in adjusting program controls.

The instrument shall have a cutoff switch and pushbutton for the manual operation of the signals connected to each circuit. Operation of these switches shall not interfere with the time setting and running of the instrument. Adjustable-time duration contacts shall be provided so that the owner can set the desired duration the signals are to be actuated. The duration shall be adjustable for a minimum of three to ten seconds. Program instruments having capacity of two or more circuits shall have two sets of

[Continued on page 264]

When you speak this plainly, it takes a top quality product to back up your words. We are certain of that backing in the Clark Type CM Manual Starter, the starter that challenges comparison with any other manual starter available today.

It's built to standards usually found only in magnetic starters. Combines not just a few, but ALL modern features . . . simplest to install, easiest to maintain, smoothest and most positive in its action . . . assures maximum protection and safety, greatest dependability and longest life.

Here's the manual starter that will do a better job on your very next installation. Please accept our challenge. Ask for the Clark Type CM Manual Starter at your wholesaler's. Give it a try. We believe that its performance will convince you.

61MS1

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- Three separate safe-locking features
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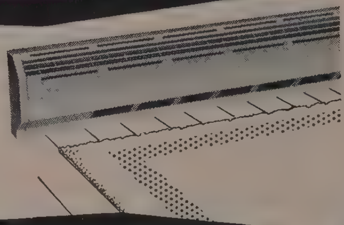

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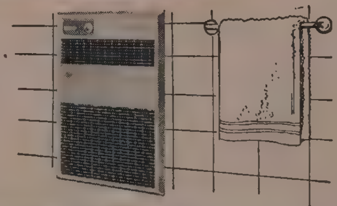

PROFIT! Arvin performance, consumer eye-appeal, time-saving installation plus good markup . . . all result in greater per-job profit with any Arvin units.

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GET FREE SPECIALIZED SERVICE . . . Arvin's Electric Heat specialists will work with you in every way, even to the outlining of an entire installation.

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ARVIN INDUSTRIES, INC., Columbus, Ind.

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duration contacts, one being connected to one circuit and the other to the balance of the circuits to be controlled by the instrument.

The program instrument shall include the necessary relays to operate the signals of the system. Should the current requirements of the signals exceed the capacity of the relay in the instrument, additional relays to carry this load shall be provided by the manufacturer. These may be separately mounted from the program instrument.

The instrument shall be so designed that the program may be easily changed by the owner.

The instrument shall be housed in a steel cabinet with hinged cover, complete with lock and key.

Install where shown, a vibrating bell (4-, 6-, or 10-in.) or horn (grille or projector type) or buzzer and wire to program instrument.

Signals installed outside shall be furnished in weatherproof construction complete with aluminum protective hood.

All signals which are to operate on the same program schedule shall be wired on the same circuit to the associated circuit terminals in the program instrument.

11.74 Operating Current

The system shall operate from the 115-volt, 60-cycle lighting supply.

11.75 Wiring

All wiring shall be of the approved type and shall meet the requirements of national, state and local electric codes. The size and number of wires shall be as specified by the manufacturer of the system.

11.8 Nurses' Calling System

A. Visual system.

B. Audio-visual, reset only at bedside, system.

C. Audio-visual, reset at nurses' station, system.

D. Psychiatric-ward alarm system.

11.81 General

Furnish and install (trade name and/or number, nurses' calling system as manufactured by—name of manufacturer) described in these specifications and indicated on wiring plans. The system shall be wired and installed in accordance with manufacturer's specifications and left in first-class operating condition.

[Continued on page 266]

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Standardized Type RAL switches are built expressly for loop-through and tap circuits such as shown here. Any section of the loop can be isolated by these switches or any load or main tapped off the loop can be bypassed without affecting service to remainder of the loop.

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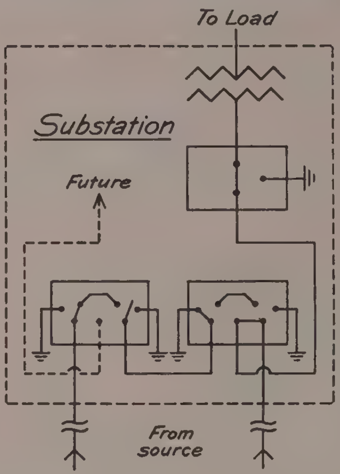
Write G&W for copy of STANRAL Data Sheet giving more information on Type RAL switches.



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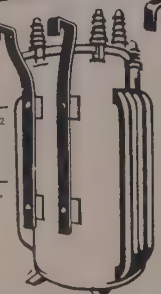

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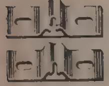

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11.0 Signal

11.82 Operation

A. Visual System.

When a patient requires assistance, he shall press a locking button, which shall light corridor dome lamp, utility dome lamp and associated room light in annunciator at nurses' station and momentarily sound buzzer signal at utility and nurses' stations. The buzzer signal may be repeated by the patient by pressing his calling button. The patients' stations in wards shall operate similarly to above, except a pilot lamp shall be lit in the patients' station to identify to the nurse when entering the room, which station initiated the call. All lamp signals shall remain lit until the operated button is reset. The buzzers in the utility stations and nurses' station shall be equipped with cutoff switches to silence the buzzer during night duty, if desired. Accidental removal of the patients' calling-button cord set shall give the light signals as though the patient had pressed his button, except that the buzzers in the system shall sound continuously. These signals may be cancelled by the nurse by a device in the receptacle of the patients' calling station, in event the calling-button cord set is intentionally removed from the wall. The patients' station shall be automatically restored to an operating condition when the calling-button cord set is replaced into the patients' station. Calls from toilets are initiated by the patient pressing a wall button, which shall light a red lamp in the corridor domes, utility stations, and nurses' station annunciator, and cause the buzzers in the system to sound continuously.

Calls from operating, delivery rooms, etc, containing combustible anesthetic agents, shall originate from foot-operated explosion-proof stations in these rooms and will give the same indications as described for toilet stations.

B. Audio-visual system, reset only at bedside.

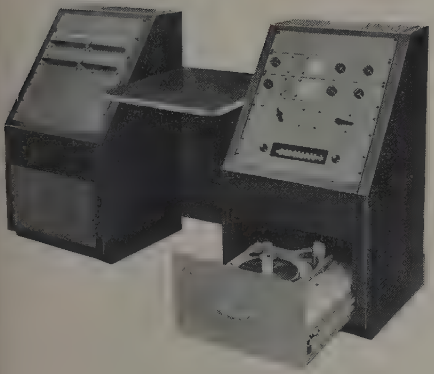
When a patient requires assistance, he shall press a locking button, which shall light corridor dome lamp, utility dome light and associated room lamp in nurses' master station, and momentarily sound buzzer signal at utility and nurses' stations. The buzzer signal may be repeated by the patient by pressing his calling button. The patients' stations in wards shall operate similarly to above, except a pilot lamp shall be lit in the patients' station to identify to the nurse when answering the call from the corridor, which sta-

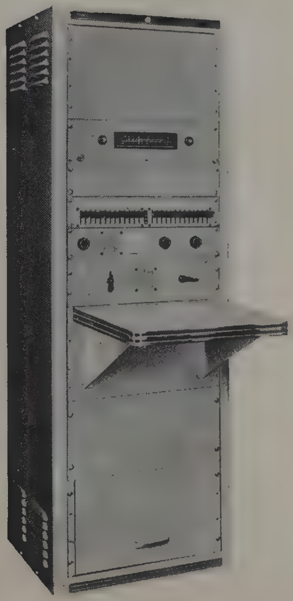
[Continued on page 269]

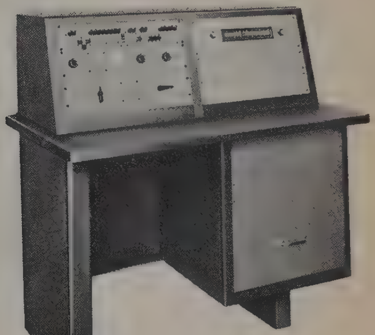
AUDIO NEWS

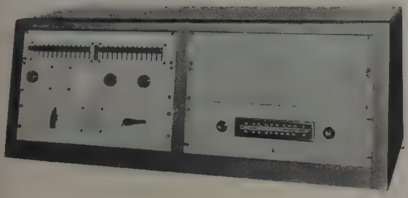
RCA

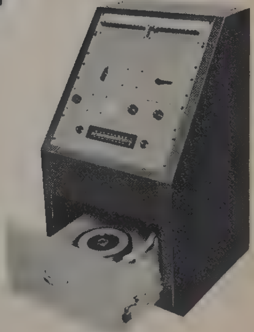
RCA SOUND SYSTEMS NOW MADE TO ORDER FROM PREWIRED PLUG-IN ASSEMBLIES











RCA's new modular sound control systems offer three important advantages:

1. Permit quick selection of assemblies to meet exact requirements. 2. Are unusually simple to operate. 3. Provide greater reliability at lower cost.

These new "building block" systems from RCA are based on the five basic cabinets illustrated and a wide selection of standard assemblies which can be installed in many combinations—affording a high degree of flexibility.

Flexibility of Design

RCA's Modular Sound Control System assemblies are mounted on 19 inch panels and stocked as standard units.

Planning and specifying an RCA system is greatly simplified—merely requires determining the functions to be accomplished by the sound system and selecting the standard assemblies and cabinet which best match the requirements. The specified elements are prewired with plug-in connections; are custom assembled by factory experts, and shipped ready for installation. Once one of these flexible systems is installed, the modular-construction concept makes later expansion easy. Service, too, and parts replacement become greatly simplified.

Simple to Operate

Simple operation combined with flexibility are characteristic of RCA's modular design. The number of operating controls, switches and knobs have been reduced to essentials without detracting in any way from the functions of the system. The *program panel,* for example, has only three controls. The *intercom panel* is equally simple and incorporates a combination monitor-loudspeaker and microphone. It also features RCA's single "'ALL-CALL" switch that instantly connects all loudspeaker locations for emergency announcements.

Easy to Install and Maintain

Reliable performance at lower cost is an inherent advantage of these new systems. Installation is readily accomplished, since the systems are shipped with all units mounted in place. Before leavingthe factory, the individual assemblies are tested and the entire system is checked out to meet RCA's rigid quality standards. Components are readily accessible for service and parts replacement.

Assemblies for RCA Modular Sound Systems are illustrated and briefly described on the next page.

RCA MODULAR SOUND SYSTEMS

MODULAR DESIGN FLEXIBILITY PERMITS CHOICE OF STANDARD OR CUSTOM SOUND SYSTEMS AT MODEST COST

This deluxe 3-channel RCA Sound System illustrates the flexibility and convenience of modular design. The modular components of this system (tuner, program panel, intercom, etc.) may be varied in location in this console, or in the desk, rack, or turret cabinets also available. This flexibility allows the sound system specifier to choose components for a system which meets the job requirements without *paying premium prices for custom assembly.*

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- Simplified program panel contains only three control knobs: volume control; a combined monitor selector and distribution switch to control program distribution; and an input selector switch. All cabling terminates in plugs for easy connection.

- Intercom panel includes a talk-listen switch and a switch for intercom—all-call selection. Monitor microphone built into the panel—separate desk microphone not needed.

Extra Versatility Afforded by Wide Range of Components

More than 500 individual audio products are offered by RCA to afford complete versatility of function and choice of performance quality. For school systems, frequently specified sound facilities include: Automatic 4-speed Record Player (manual turntable provided with basic systems); High Fidelity Dual Track Tape Deck; Microphone Mixer Panel; Room Privacy Switches; Telephone Intercommunication facility.

Detailed Information Available at Your Request

For information and specifications on New Modular Sound Systems and their assemblies, write to RCA or ask your Sound Distributor. Four "Select-A-Guide" booklets have been prepared to illustrate and provide specification information on RCA Audio Products. These are available on request, and should be identified by form numbers.

Modular Sound Select-a-Guide—3J3668 Rev. 2
Microphone Select-a-Guide—3R3287
Amplifier Select-a-Guide—3R3833
Loudspeaker Select-a-Guide—3R3509

Send requests to RCA, Audio Products, Building 15-1, Camden 2, New Jersey.

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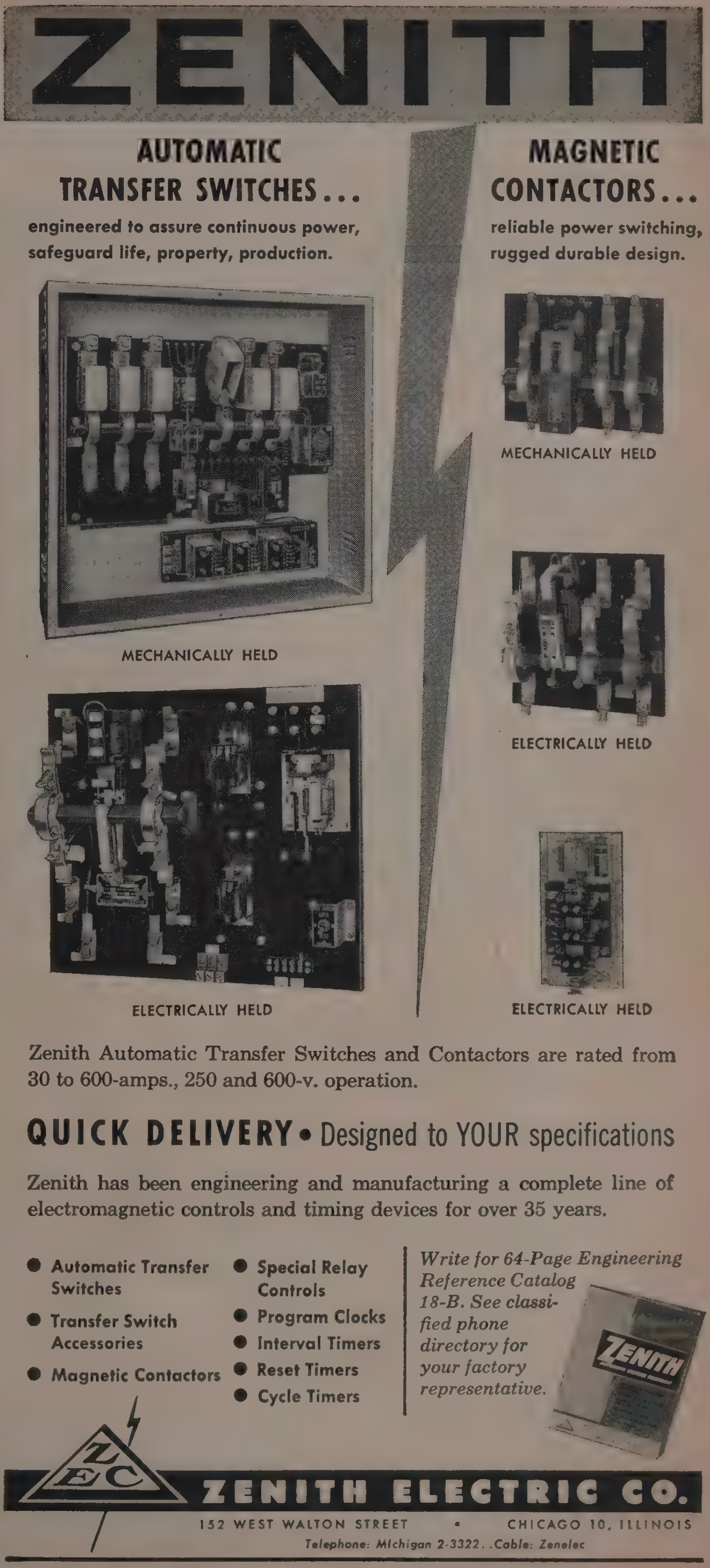
tion initiated the call. All lamp signals shall remain lit until the operated button is reset. The buzzers in the system shall be equipped with cutoff switches to silence the buzzer during night duty if desired. Accidental removal of the patients' calling-button cord set shall give the same light signals as though the patient had pressed his button, except that the buzzers in the system shall sound continuously. These signals may be cancelled by the nurse by a device in the receptacle of the patients' calling station in event the calling-button cord set is intentionally removed from the wall. The patients' station shall be automatically restored to an operating condition when the calling-button cord set is replaced into the patients' stations. Calls from toilets are initiated by the patient pressing a wall button, which shall light a red lamp in the corridor domes, utility stations and nurses' master station, and cause the buzzers in the system to sound continuously. The nurse shall be able to establish two-way conversation with the patient after throwing a key or pressing a button associated with the lit room lamp on the master station and using the handset of the master station. The patient may carry on the conversation from his normal position in bed through the speaker-microphone of his station. When the conversation is completed, the nurse may request the patient to reset his button if a trip to the bedside is not necessary. Note: The following should be specified if the hospital has the requirement that the patients in private rooms shall be able to prevent the nurse at the master station to listen-in or monitor his station without a call having been initiated by the patient.

It shall be possible for the patients in private rooms to obtain privacy from the nurse monitoring his station by a switch on the patients' room station. Throwing this switch to the "Privacy" position will prevent the nurse from listening to the patient's station, but shall not prevent the nurse from speaking to the patient. (This feature is desirable so that the nurse may request the patient to throw his privacy switch back to normal so that a call placed by patient may be heard.)

Calls from operating, delivery rooms, etc., containing combustible anesthetic agents, shall originate from foot-operated explosion-proof stations in these rooms and shall give the same indications as described for toilet stations.

Failure of the amplifier or audio

[Continued on page 270]



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circuits of the system shall not prevent the lamps of the system from registering.

C. Audio-Visual, reset at nurses' station, system.

When a patient requires assistance, he shall press a pendant-type momentary call button, which shall light corridor dome light, utility dome lamp and associated pilot lamp on master station, and momentarily sound buzzer signal at utility and nurses' station. Nurse shall establish communication with patient by throwing the key switch or pressing button associated with the lighted pilot lamp on the master station; and as soon as the nurse starts a conversation with the patient, all lamps shall be automatically reset. The call may also be reset at the bedside by pressing the reset button in the patients' station. The nurse may monitor any room by merely throwing that room key on the master station. Patients' privacy, when required, may be obtained, depending upon the type of system specified as follows: (Specify one type of privacy.)

Type 1. By a green pilot lamp on the patients' station being lit whenever nurse monitors that station.

Type 2. By a privacy switch on the patients' station which when thrown, will prevent nurse from listening to room, but will allow nurse to talk to patient. This is desirable so that nurse may request patient to restore privacy switch to normal so that a call placed by patient may be answered.

All cord-jacks shall be equipped with safety feature which automatically lights all lights and continuously sounds all buzzers when cord is accidentally removed from jack. If cord is to be removed for cleaning or servicing, a plug shall be inserted into the jack of the patients' station.

Wall-type locking button stations in toilets and baths shall light red lamps in corridor, utility and master station and sound all buzzers continuously until reset. Foot-operated explosion-proof station shall give same operation as toilet stations in operating and delivery rooms.

Failure of the amplifier or audio circuits shall not prevent the lamps of the system from registering.

D. Psychiatric-ward alarm system.

Before entering a room, the nurse operates key switch at room entrance station, which shall light the white lamp in corridor dome and white room indication in nurses' station annunciator, and energize the calling button

[Continued on page 272]

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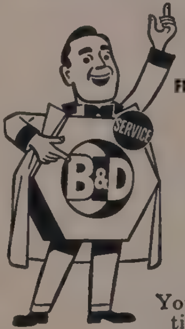

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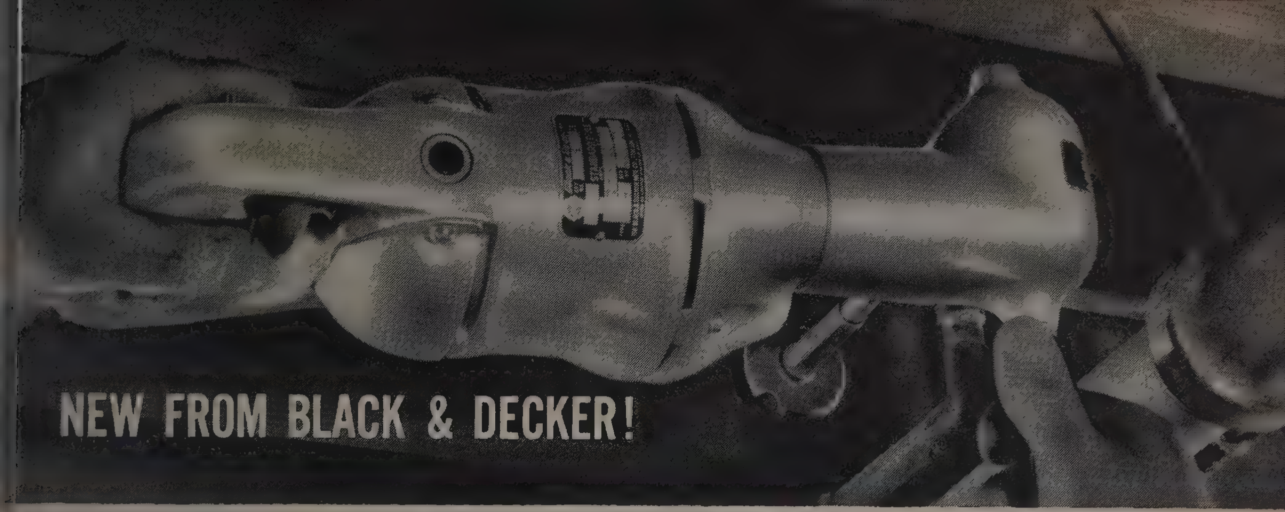

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To cut through wood, metal and plaster . . . you do it faster with the Black & Decker Sabre Saw's exclusive long-stroke action. Unique rock 'n' lock shoe design, a blade spindle that turns 90° and 180°, a safeguard blade guide for up-front control . . . all give you sure cutting accuracy, solid sawing performance.

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This is the little fella

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See it? That condenser up there isn't paper (the usual thing), but *ceramic*. It's in every Sylvania starter and the difference it makes in performance will surprise you.

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Paper can't stand up as well to heat, cold, moisture. Ceramic condensers do. Another reason why Sylvania alone can give you an exclusive Certified Performance Policy *guaranteeing:* "If at any time, in your opinion, any Sylvania Fluorescent Starter fails to give satisfactory service during the 12 months from date of purchase, it may be returned to the supplier for full refund of purchase price."

Yes, Sylvania lowers your TCL (Total Cost of Lighting). That means lower cost of lamp plus power plus MAINTENANCE. Try Sylvania next time you need starters!

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Subsidiary of
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Lighting Division, Sylvania Electric Products Inc.,
Dept. 15, 60 Boston St., Salem, Mass.
In Canada: Sylvania Electric (Canada) Ltd., Montreal.

in the room. Should nurse need assistance when in the room, she touches the calling button, which shall light the red lamp in corridor dome and red room indication in nurses' station annunciator, and sound the alarm bell in the annunciator and all other alarm bells as shown on the plans. These lamps and audible signals cannot be cancelled until the room entrance station is reset by key.

11.83 Equipment

Aa. Install in all private rooms as shown on the plans, a nurses' calling station consisting of a receptacle for the calling cord mounted on a single-gang subplate to which there shall be installed a stainless-steel wall plate. The station shall be complete with detachable calling-cord set, consisting of plug, 6-ft 5-conductor cord and durable locking button with reset feature. This cord set shall be interchangeable with the double cord sets specified for semi-private rooms (Ab) as to mounting in the station receptacle.

Ab. Install in all semi-private rooms as shown on the plans, mounted between the beds, a nurses' calling station of the same type as specified for private rooms (Aa), except a double cord set shall be furnished. This double cord set shall be interchangeable with the single cord sets as to mounting in the station receptacle.

Ac. Install in all wards or rooms having more than one pair of beds, as shown on the plans, nurses' calling stations similar to those specified for semi-private rooms (Ab), except that the station shall also include a pilot lamp.

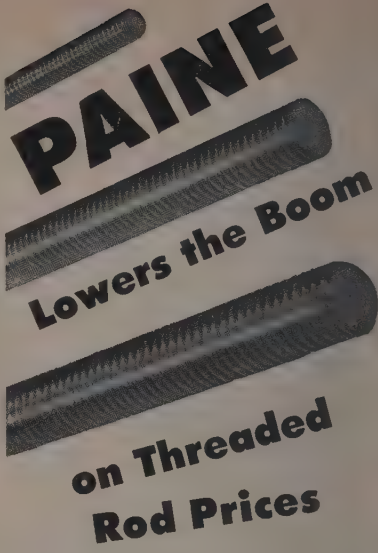
Ad. Install in all toilets and bathrooms as shown on the plans a (1) wall, type locking button (2) pull cord, nurses' calling station mounted on a single-gang subplate with stainless-steel wall plate.

Ae. Install on each porch or balcony as shown on the plans, a nurses' call station similar to that specified for the private rooms (Aa), except that it shall be weatherproof and provided with screw-on cover for the receptacle, rubber gasket between the wall plate and the wall, and the cord set shall be 15 ft long.

Af. Install in operating, delivery and other rooms having combustible anesthetic agents, a foot-operated explosion-proof station.

Ag. Install in the corridor over each patient's room or ward as shown on the plans, a dome-type corridor station. This station shall consist of a lamp, mounted on a 2-gang subplate

[Continued on page 274]



New equipment added to our plant facilities makes it possible for us to produce threaded rod more economically than ever before. In turn, we're passing the savings on to you. Check with us for very competitive prices.

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Paine Threaded Rod is manufactured from high quality basic wire and has rolled threads. Rods can be bent without heating to make "U" Bolts, Eye Bolts, etc.

All standard thread sizes and lengths are available from Paine. Special sizes and lengths will be made to your specifications. Insist on high quality *and* low prices. Order Paine Threaded Rod.

STOCK LENGTHS—
(Steel, Plated, and Brass)

	2′	3′	6′	10′
6-32	x	x		
8-32	x	x		
10-24	x	x		
10-32	x	x		
12-24	x	x		
1/4-20	x	x	x	x
5/16-18	x	x	x	x
3/8-16	x	x	x	x
7/16-14	x	x	x	x
1/2-13	x	x	x	x
5/8-11	x	x	x	x
3/4-10	x	x	x	x
7/8-9	x	x	x	x
1-8	x	x	x	x

Paine offers a complete range of sizes in big washers, big square or hexagon nuts, standard wrought washers and hexagon steel, unplated rod couplings.

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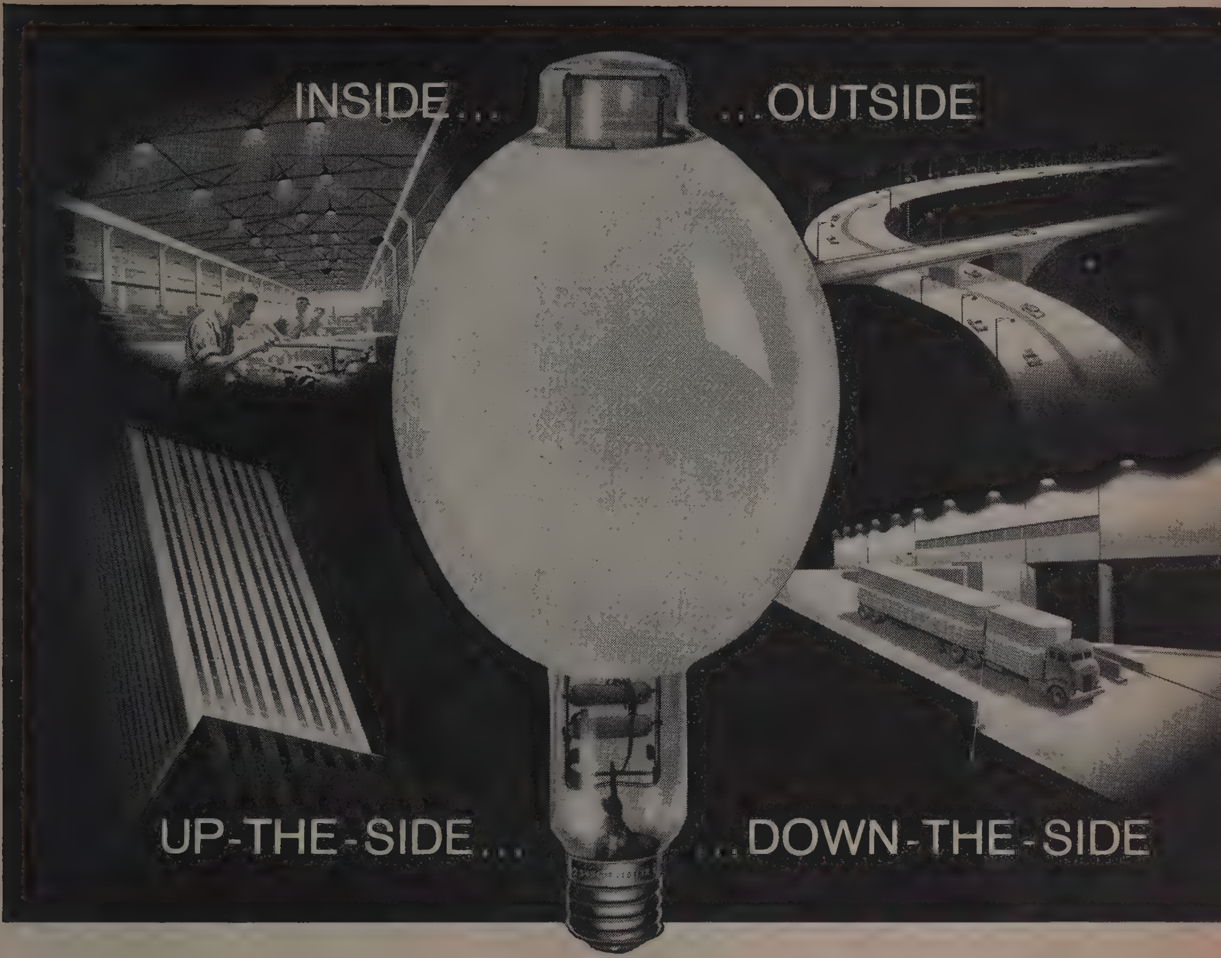

Only new Sylvania Banner Mercury Lamps deliver all these advantages for indoor-outdoor lighting:

1. Longer life! Now extended to 12,000 hours. With greater maintained brightness giving a dividend of *17% more light during life* than standard mercury lamps.

2. More light! Almost triple the light of incandescents on the same power! Makes Banner Mercury Lamps ideal for street lighting, facades, industrial installations.

3. Ruggedized construction! Shocks, vibrations, fiercest weather don't stand a chance. Hard glass shell protects on the outside; welded multiple supports, springs protect on the inside, assure longer life.

4. Life recording base! Unusual feature saves time, paper work by letting you scratch installation date in numbers right on base of lamp.

5. Certified Performance Policy guarantees: "Banner Mercury Lamps may be returned to the supplier for full exchange if they fail in less than 1000 burning hours, and thereafter (up to 5000 hours) for pro-rata exchange, in accordance with a pro-rata exchange value table set forth clearly in the policy form."

PLUS Lowest TCL (Total Cost of Lighting), which means cost of lamps plus power plus maintenance. Get the most light for your money. Call your Sylvania representative. Or write: Lighting Division, Sylvania Electric Products Inc., Dept. 15, 60 Boston St., Salem, Mass. In Canada: Sylvania Electric (Canada) Ltd., Montreal.

Certified Performance Policy for... BANNER MERCURY LAMPS

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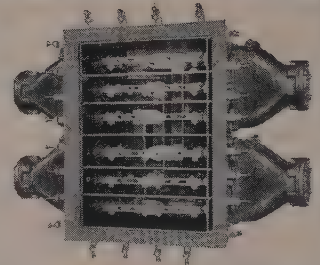
GENERAL SYSTEM

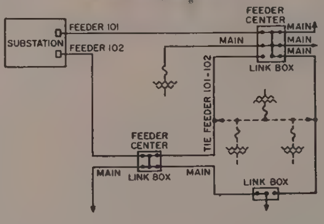
Make your underground primary system operation
FLEXIBLE with G&W SECTIONALIZING BOXES

Maximum flexibility in planning and operating underground primary cable systems is found when G&W Sectionalizing Boxes are used. Sections of cable can be isolated or reconnected quickly and inexpensively merely by removing or inserting links in the cable boxes. Breaking and remaking cable joints for cable fault location or repair is no longer required. Added bonus is that remainder of circuit can be returned to service during emergency operations.

G&W Sectionalizing Boxes are available for any conceivable number of cables and can be furnished with blank ways for addition of future circuits. All boxes are hermetically sealed and submersible. Standard types are available for operation to 34.5 kv.

Write to G&W for additional information on G&W Sectionalizing Boxes or call the nearest G&W sales representative.





Typical circuit using G&W Sectionalizing Boxes

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MODEL "VAP" (480 V.)
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and a stainless-steel 2-gang plate having mounted thereon a glass or translucent plastic dome hinged and fastened to the plate. For those patients' rooms having toilets, the station shall contain a red and white lamp with horizontal barrier between the lamps, under the dome.

Ah. Install in the utility, diet kitchen, duty rooms, etc., as shown on the plans, a station consisting of a 3-gang subplate mounted thereon a buzzer with cutoff switch and two lamps (one red, one white) and 3-gang stainless plate, mounted thereon a hinged glass or translucent plastic dome having horizontal barrier between the two lamps.

Ai. Install at the nurses' station on each floor as shown on the plans, a flush lamp annunciator with metal trim and hinged door. The annunciator shall contain the necessary number of room indications to receive the calls from all rooms (one per room) having calling stations, which shall indicate the room number by a white lamp behind a translucent marking plate. Calls from the toilets shall be indicated by a red lamp behind the translucent marking plate. These plates shall be easily removable for lamp replacement. The annunciator shall contain a buzzer with cutoff switch, accessible from the front.

Aj. All lamps and signals in the system shall be 24-volt secondary of a heavy-duty signaling transformer as indicated on the plans. This transformer shall have sufficient capacity to light one-fourth of all the lamps in the system on that floor. There shall be at least one transformer of this type on each floor. The primaries of all of these transformers shall be connected to the 115-volt, 60-cycle lighting supply.

Ba. Install in all private rooms as shown on the plans, a nurses' calling station having subplate construction for mounting on multi-gang outlet boxes. Mounted on the subplates, there shall be a receptacle for the calling cord and a sensitive microphone-speaker protected by a metal grille. (Note: If the privacy feature is required, insert the following: A privacy switch shall be included on the station so arranged that when thrown to the "Privacy" position, it shall prevent the master station from listening to this station; however, this shall not prevent the nurse at the master station from speaking to the patient.) The faceplate shall be stainless steel. The station shall be complete with detachable calling cord set, consisting of plug, 6-ft

[Continued on page 276]

FROM THE MANUFACTURERS OF CONDUIT SINCE 1912...

HIGH QUALITY

RIGID STEEL CONDUIT

A TYPE TO MEET ALL REQUIREMENTS

HOTKOTE—Special, hot-galvanized exterior and interior surfaces provide bond with concrete and allow easy pulling of wires. Threads hot galvanized after threading to prevent rusting. U/L Approved and meets Fed. Spec. WWC 581c.

GALVAKOTE—Electro-plated exterior, including threads, prevents corrosion, assures long life. Interior surface evenly coated with baked-on enamel to provide smooth finish for easy "fishing". Will not flake or chip. U/L Approved and meets Fed. Spec. WWC 581c.

ENAMELKOTE—Both interior and exterior surfaces coated with high-grade, baked-on black enamel. Bends, cuts and threads easily without flaking. Accurately cut standard gauge threads. U/L Approved and meets Fed. Spec. WWC 571a.

And to complete the conduit line . . .

ELECTRICTUBE EMT—Satin-finish, close-grained, electro-galvanized EMT has exceptional corrosion-resistant life. Super-smooth interior surface permits easy fishing of wire. Bends easy . . . saves money on job. U/L Approved and meets Fed. Spec. WWT 806b.

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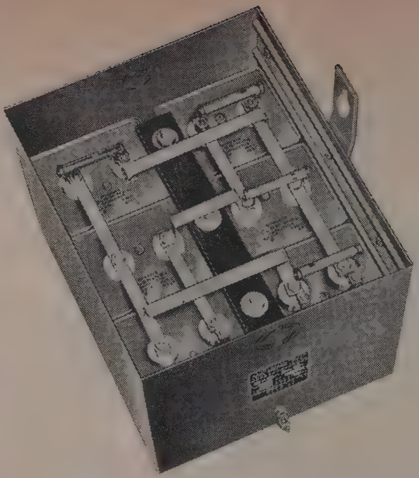

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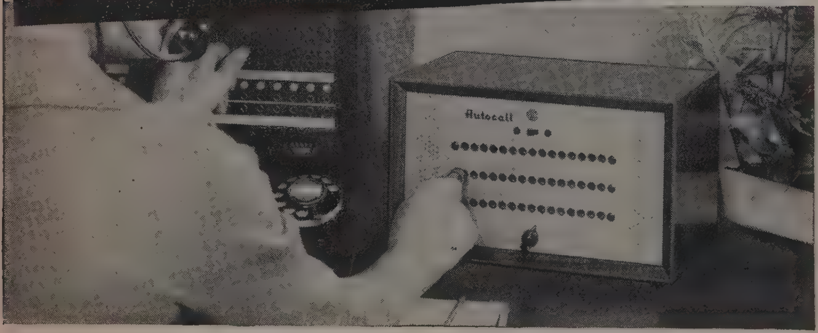

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5-conductor calling cord and durable locking button with reset feature.

Bb. Install in all semi-private rooms, as shown on the plans, mounted between the beds, a nurses' calling station of the same type as specified for private rooms (Ba), except a double cord set shall be furnished.

Bc. Install in all wards or rooms having more than one pair of beds as shown on the plans, nurses' calling stations of the same type as those specified for semi-private rooms (Bb), except that the station shall also include a pilot lamp.

Bd. (Same as paragraph Ad.)

Be. (Same as paragraph Ae.)

Bf. (Same as paragraph Af.)

Bg. (Same as paragraph Ag.)

Bh. (Same as paragraph Ah.)

Bi. Install at the nurses' station as shown on the plans, a master station, portable type, having an indicating lamp for each room having a speaker-microphone station (Ba, Bb, Bc) and associated keys or buttons. The master station shall be complete with a handset, supervisory lamp, emergency lamp, buzzer with cutoff switch and switch on front for varying the sensitivity of the bedside speaker, amplifier with cord and plug. A flush (or surface) terminal box shall be installed as shown on the plans to accommodate the system wiring to the calling stations and shall be connected to the master station by flexible cables.

Bj. (Same as paragraph Aj.)

Ca. Install in all private rooms a nurses' calling station as shown on the plans having subplate construction. Mounted on the subplate there shall be a receptacle for the calling cord, a sensitive microphone-speaker, relay with protective cover, reset button and terminal strip. (Note: If Type 1 privacy is specified in operation, insert the following, "and green pilot lamp." If Type 2 privacy is specified insert the following, "and privacy switch.") The faceplate shall be stainless steel. The station shall be complete with cord set, consisting of momentary pushbutton, 6-ft of cord and plug.

Cb. Install in all semi-private rooms, a nurses' calling station mounted between the beds as shown on the plans a nurses' calling station which is the same type as those installed in private rooms (Ca) except it shall have two calling cords.

Cc. Install in all wards or rooms having more than one pair of beds, as shown on the plans, nurses' calling stations of the same type as (Cb) except that the station shall also include a pilot lamp.

[Continued on page 278]

When dependability
is of vital nature
...a natural selection
is proven-quality

The consistent selection of Paranite by Power Users in all parts of the country is significant of its dependability. Producing reliable, high-quality power cable has been a Paranite specialty for 71 years... from 600 volt network through 28,000 volt power cable. You can depend upon it... "If it's Paranite, it's right.®"

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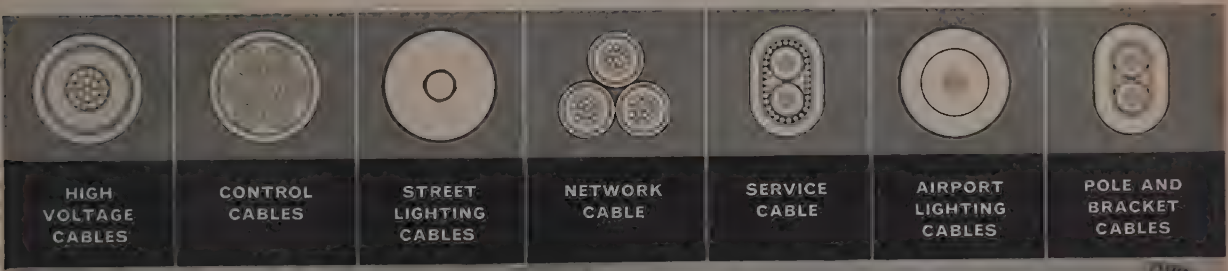
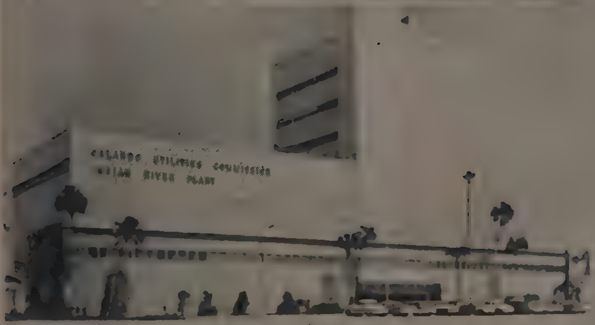


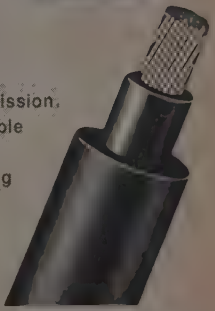
The Enrico Fermi Atomic Power Plant

near Monroe, Michigan, operated by the Power Reactor Development Company and the Detroit Edison Company. Paranite was selected to supply 600 V. network and 5,000 V. shielded cable for the nuclear section. Illustrated at right is a typical Paranite Power Cable.



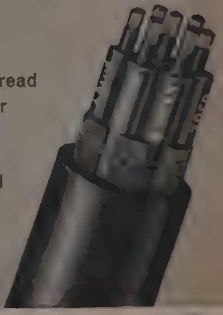
Indian River Generator Plant

of the Orlando, Florida, Utilities Commission. From transmission line... to power cable ...through control cable... Paranite was specified to carry the load in serving this growing area. Illustrated at right is one of Paranite's complete line of 600 V. Network Cable.



Missile Bases

provide another example of the widespread and diversified use of Paranite in power distribution throughout the nation. Paranite Control Cables are produced in a complete range of insulation and jacket types. Illustrated at right is a typical Paranite Control Cable.



For more information on high voltage, control, street lighting, network, service and airport cables contact your local Paranite representative... or write Paranite Wire and Cable Division, Dept. 204, 2601 S. Adams St., Marion, Indiana.

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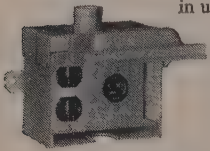
MODEL "50-15" solves power problems for Mobile Home Parks because it receives a wide variety of plugs. Offers a 50 amp. 250 volt 3-wire power receptacle, and a 15 amp. grounded duplex receptacle. Protected with two 50 amp. circuit breakers and fuse. Ample space for plug-in adapters when needed. Top hub and bottom knockouts facilitate overhead or underground connections. Completely weatherproof. Cover closes and can be padlocked when in use. Cords hang through rounded cord slots.



MODEL 34 offers 15 amp., 125 volt grounded duplex receptacle with 15 amp. fuse protection. Sixteen other "Hoffman" power outlets are available with choice of 15, 20, 30, 35 and 50 Ampere receptacles to fit your exact needs. Write us.

Stocked and sold by leading electrical distributors.

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Wings spring to open position instantly — grip firmly when bolt is tightened.

NOTHING HOLDS AS WELL AS ACKERMANS

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ORIGINATORS OF THE EXPANSIVE SCREW ANCHOR

Cd. (Same as paragraph Ad.)
Ce. (Same as paragraph Ae.)
Cf. (Same as paragraph Af.)
Cg. (Same as paragraph Ag.)
Ch. (Same as paragraph Ah.)
Ci. (Same as paragraph Bi.)
Cj. (Same as paragraph Aj.)

Da. Install in corridor outside each room as shown on the plans, a room entrance station, including cylinder key switch, relay and terminal strip with stainless-steel wall plate. All fastening screws shall be tamperproof type.

Dc. (Same as Ag with red and white lamps.)

Dd. (Same as Ai, having red and white lamps under each marking plate and with bell in lieu of buzzer and without cutoff switch.)

De. Install in the corridors and at places shown on the plans at 10-in. vibrating alarm bell in flush box with grille front.

Df. (Same as paragraph Aj.)

11.84 Wiring

All wiring shall be of the approved type and shall be installed in accordance with the wiring diagram and instructions of the manufacturer.

11.9 Television Systems

11.91 Antenna System

Furnish and install a (trade name and/or number) television antenna system as manufactured by (name of manufacturer) described in these specifications and indicated on wiring plans. The system to be wired and installed in accordance with the manufacturer's specifications and left completely equipped and in first-class operating condition.

A. Television antenna system, amplified: Install custom-built television antennas for channels (mention channel numbers) as desired. There shall be installed six antennas on each mast with coaxial cable to each apartment, each antenna shall be designed to match the coaxial cable transmission line. The quality of the television signal for each channel received shall be equal or superior to that which could be obtained by the use of an individual antenna for each outlet. Wiring from each antenna to the amplifier units shall be in a coaxial cable as recommended by the manufacturer. The system shall be complete with television set outlets and ground wire. The antennas shall be properly supported and braced. They shall clear

[Continued on page 280]

6 bonuses when you specify and/or install PTC TRANSFORMERS

bonus NO. 1 . . . EXTREME QUIETNESS

Quiet transformer operation with low loss is a blessing and a real source of satisfaction to building owners, managers, top executives, employees and patrons. Therefore a superior low noise level is an extremely important reason why you should specify and/or install PTC transformers on all jobs.

Look at these PTC low noise levels as they compare with present and recommended NEMA specifications.

KVA Transformer Rating	Present NEMA	Precision Average Sound Level Standard Design	Precision Average Sound Level Special Design
9—30	50	40	34
37½—112½	55	42	38
125—167	60	44	42
200—300	62	48	46

To recognize the extreme quietness of PTC transformers it is best to compare them in decibel sound level ratings with those of typical sounds familiar to everyday life.

FOR EXAMPLE:

60-70 decibels—the sound of one typewriter or average traffic sounds 100 ft. away.

50-60 decibels—the sound of a vacuum cleaner or moderate restaurant clatter.

40-50 decibels—the noise to be found in an average residence or in normal conversation.

30-40 decibels—low conversation in a residence in the evening.

bonus NO. 2 . . . EFFICIENCY

Transformer losses cost money. Precision transformer cores ① use the lowest loss steel available. Precision transformers are wound with low resistance copper wire and designed for the greatest possible operation economy. These features reduce losses and save dollars not once, but year after year.

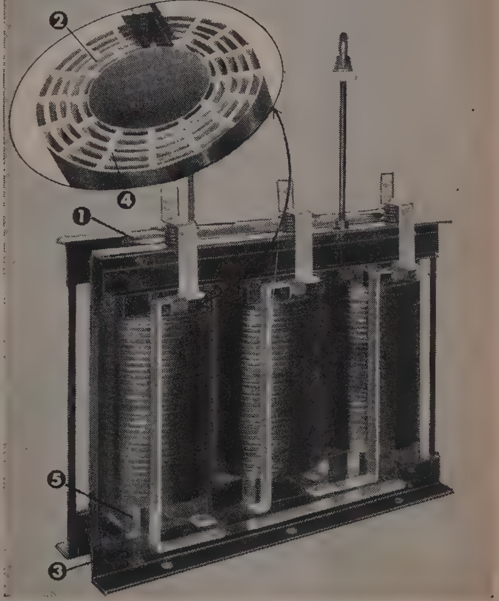
bonus NO. 3 . . . OVERLOAD CAPACITY

Precision transformers are designed with large open ducts ② for efficient cooling and operate at lower temperatures than specified in national standards. Superior PTC insulation materials, varnishes and wire enamels actually permit operating temperatures in excess of these standards with no loss of life. These factors together with low losses give Precision transformers unequalled ability to handle overloads.

bonus NO. 4 . . . DEPENDABILITY AND LONG LIFE

Dependability and long life can result only from ADVANCED DESIGN and BUILT-IN QUALITY. PTC transformers excel because they are constructed to meet the varying conditions under which they must be used. Additional PTC features are:

- Core laminations are clamped together with structural steel ③ rather than formed sheet steel for more rugged construction.
- Glass laminate duct spacers ④ used provide greater toughness, rigidity, dimensional stability, and moisture resistance far in excess of wood or paper phenolic laminate spacers.
- Coils are thoroughly clamped and braced around the core with fibre-glass laminate insulating blocks ⑤ resulting in greatest structural and tensile strength.
- Coils are made with an interlayer and interwinding insulation of Mylar-Quinterra and glass, assuring high dielectric strength, low moisture absorbtion and high temperature stability characteristics.



bonus NO. 5...REDUCED INSTALLATION EXPENSE

Well designed and easily accessible mounting provisions together with ample connecting space and simple wiring termination mean neater installations at lower than normal cost.

bonus NO. 6 . . . THE ONLY 5-YEAR UNCONDITIONAL GUARANTEE IN THE INDUSTRY

Your reputation as an electrical engineer or contractor depends upon YOUR ability to stand firmly behind your recommendations and installations.

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Precision Transformer Corporation has developed a unit which installs *inside-the-wall* in otherwise unusable space. Precision's "HUSH-FLUSH" design permits easy, full accessibility, lowest noise level close to lead power service. Saves material and labor costs. Ideal for schools, libraries, hospitals, churches, theatres, etc. — wherever noise *must* be eliminated.

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Whatever your transformer needs, there is a dependable, quiet, long-lasting dry or liquid type transformer . . . more than 4,000 models ranging from ¼ to 5,000 KVA.

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- EFFICIENT
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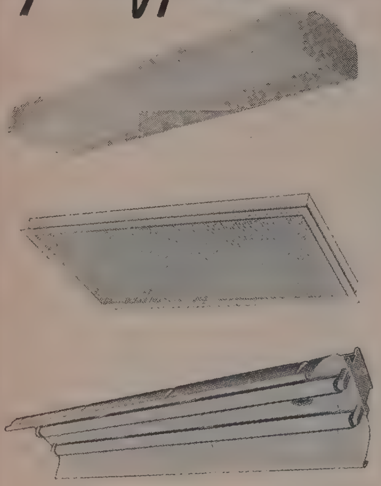

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finds outlets fast after plastering

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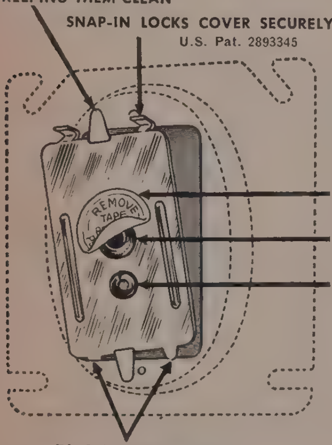
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SNAP-IN LOCKS COVER SECURELY
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RECESSED BLUE DOT TABLET
INDENTED—REMOVE TAPE QUICK-EASY
TABS SECURES ONE END QUICKLY INSERTED

Specified by ELECTRICAL—GENERAL - PLASTER CONTRACTORS ARCHITECTS and ENGINEERS . . .

A Code Cover outlet protector and locator shall be installed in all wall outlets. This is an improved flush metal device which does not interfere with plastering, protects against the entrance of plaster, or foreign objects and allows the insertion of wires in raceways before plastering.

1. Just snap Code Cover into outlet box and peel off protective tape. A small tablet of dye is held in the cavity.

2. Plaster the entire wall solid. A small spot of color bleeds through the plaster and spotlights the outlet.

3. Push in plaster at the Blue "spot", remove Code Cover . . . and discard. Outlet opening is left sharp and clean.

Approved for inserting wires before plastering

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- CODE COVER CO. • BOX 88 • OAK PARK, ILLINOIS

the roof by at least 15 ft and be arranged so that there will be no interference between antennas. Outlets shall be installed at locations shown on plans.

11.92 Equipment

Aa. Install in each suite where shown, a television set outlet on single-gang metal (or plastic) plate for connecting the set to the antenna.

The outlet device for television shall be designed to completely isolate all apartments from each other, so that a short circuit, open circuit or a defective television receiver connected to any receiver outlet, shall not affect the operation of any other television receiver connected to the system. The receiver outlet shall have a compensating attenuation network, so that the signal level in the last apartment on the coaxial transmission line will be approximately the same as that of the first apartment on the transmission line. The signal level at the outlets shall not be less than 1,000 micro-volts on the various television channels.

Ab. Install a multi-channel amplifier where shown in ventilated steel cabinet. This shall consist of a heavy-duty power-supply unit, a separate amplifier for each television channel and a separate amplifier for the FM channel. Provision shall be incorporated in the amplifier so that additional television channels may be installed if necessary in the future. The amplifier shall be designed for continuous duty and shall consume not more than 300 watts of power when operated on a 125-volt 60-cycle line. A filter shall be incorporated to eliminate all FM and diathermy interference from the television channels.

Ac. Distribution equipment and line splitters for supplying branch feeders from the main trunk line may be either electronic or passive. Each feeder line shall be completely isolated from any other feeder line. They shall be completely wired in suitable steel cabinet and equipped with coaxial receptacles and plugs for connection of incoming and outgoing cables. All wiring from amplifiers to distribution and from distribution equipment to outlets shall be coaxial transmission cable.

Ad. Install where shown on roof, necessary number of antennas to provide service on all television channels specified. These shall be of the directional type and connected to coaxial cable. Where received signals at the antenna are weak, high-gain, low-noise

[Continued on page 282]

How to combat these electrical raceway problems

GALVANIC CORROSION *USE RIGID STEEL CONDUIT.* Its zinc coating guards it thoroughly against corrosive action when buried in concrete or soil. And it is fully compatible with all common building materials.

ELECTRICAL FIRE HAZARDS *USE RIGID STEEL CONDUIT.* Because it has good conductivity, and positive coupling, steel grounds out induced and imposed currents without danger. The strength and toughness of steel protects wiring from physical damage.

SHORT SERVICE LIFE *USE RIGID STEEL CONDUIT.* Numerous installations over 50 years old are still in service; those going in today will be serviceable even longer.

EXPENSIVE UPKEEP *USE RIGID STEEL CONDUIT.* It outlasts any number of rewirings. Its tightly bonded zinc and enamel coatings remain attractive throughout its service life.

PROTECTION OF EXPOSED RUNS *USE RIGID STEEL CONDUIT.* The strength of steel resists damage from moving objects, thus providing electrical wiring with the most thorough and dependable mechanical protection available.

REWIRING DIFFICULTIES *USE RIGID STEEL CONDUIT.* Fish tapes cannot damage its smooth, hard interior, and wiring is easy to pull in. Easy to pull out and replace, too, even many years after installation. Altering the wiring system is simple and quick where spare conduit capacity has been provided.

HANDLING DAMAGE *USE RIGID STEEL CONDUIT.* Because of its great strength, steel conduit needs no special handling, no "babying." It stays round and straight, resisting damage from all but the most severe treatment.

SLOW DELIVERY *USE RIGID STEEL CONDUIT.* Good inventories of standard types and sizes of steel conduit and fittings are always maintained by pipe mills and electrical distributors. When you specify rigid steel conduit, you're sure to be able to get it when you want it.

SPECIAL INSTALLATION EQUIPMENT *USE RIGID STEEL CONDUIT.* Electrical contractors are used to working with steel conduit, and already own—and know how to use—the necessary installation equipment. Steel conduit requires no special tools nor handling techniques.

First in wiring protection for over 50 years, rigid steel conduit is the strongest answer to all your electrical raceway problems. Your electrical distributor will be glad to supply the details. Ask him about steel conduit soon.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

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... economy
... versatility

BETHLEHEM STEEL

BETHLEHEM STEEL

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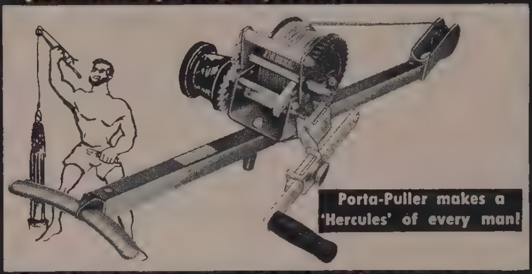
PORTA-PULLER
with BULL WHEEL makes rope or cable pulls of any length possible.


Porta-Puller makes a 'Hercules' of every man!

From the originators of portable-wire pullers comes a great new model "THE HERCULES", (illus. above). Porta-Puller number 1, bought by over 1,500 electricians, was tested and proved on the job. Now the new Hercules model Porta-Puller:
1. New stronger frame
2. New double reduction winch
3. New heavy duty bearings
4. New double extra strong pulley head
5. New stronger supporting stub
See your supply house or write for full facts and free 10-day trial offer.

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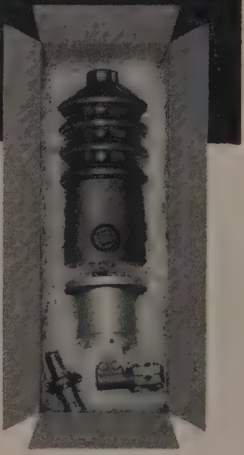
PASSAIC AVENUE AT PIER LANE, CALDWELL, N. J.

G&W POTHEAD UNIT PACKAGING
speeds installation;
cuts inventory and costs!


G&W standard capnut Pothead ready for shipment as a typical Unit Package.

Every component, device, and accessory required for installing a G&W standard Pothead is quickly gathered from "off-the-shelf", carefully and securely packaged, and shipped *complete* in a single carton. Once put into inventory, the needed number of potheads may be drawn from stock, unpacked right at job-site, and put into service in short order. Not only are substantial inventory savings affected, but installation costs materially are reduced.

Unit Packaging is another benefit gained from G&W's constant development of cable accessories and switchgear; another reason why it profits you to recommend, specify, and install G&W equipment. Ask a G&W representative, or write for information about G&W potheads and terminations.

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TORONTO, MONTREAL & VANCOUVER
superior quality standards — inspired specialized design
G61-1

figure pre-amplifiers shall be used to increase the signal levels to the rated input of the master amplifier.

11.93 Operating Current

All power outlets for sets shall be connected to the lighting system in the suites and shall not be combined in same outlet box with the television set outlet. Amplifiers shall be connected to separate circuit from nearest lighting panel supplying current to the building proper.

11.94 Wiring

All wiring shall be run in approved conduit in the same manner as for the lighting system. The lead-in or down-lead wires for television shall be coaxial cable of the size and type as recommended by the manufacturer of the antenna system. Wires for ground connection shall be as recommended by the manufacturer of the antenna system. Coaxial cable shall be run in continuous lengths from the antenna to the amplifier and distribution units. This cable shall be connected to the individual television outlets by means of solderless coaxial connectors.

11.95 Closed-Circuit TV

Closed-circuit video systems may consist of (a) fully equipped systems, (b) wiring systems with receptacles and conductors in place for attachment of equipment, (c) raceway and outlet systems for future installation of conductors and receptacles. Specifications should detail equipment to be provided and methods of attachment to the permanently installed wiring system. Particular note should be made of the method of mounting and control of cameras as these may be fixed, manually adjustable or remotely positioned and controlled.

Sound communication with TV broadcasting is usually provided by a separate system of microphones, amplifiers, wiring and speakers. The sound wiring may be run in the same raceway as the video wiring.

Video wiring consists of a system of coaxial cables with appropriate connectors and terminations. Terminations are networks at the outlet providing an optimum impedance match, signal level and blocking between receivers. Manufacturer's recommendations for wiring terminations and connections should be carefully observed.

Video wiring systems are installed in conventional metallic raceway sys-

[Continued on page 284]

how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS

to support cables in their Indiana Harbor Plant

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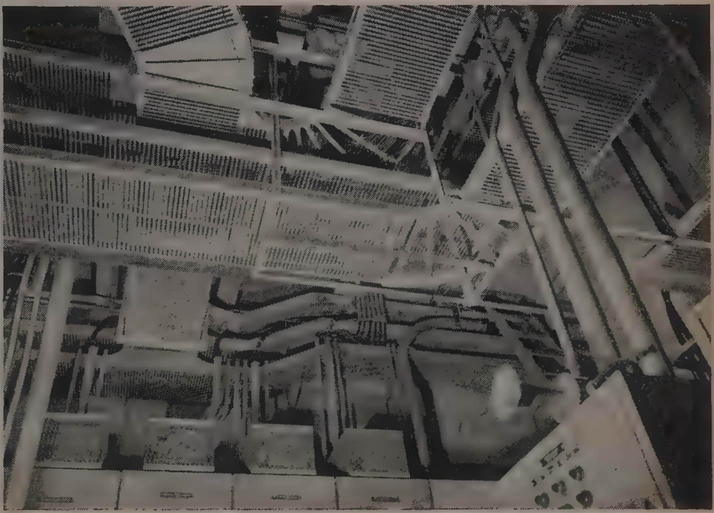

Globetray
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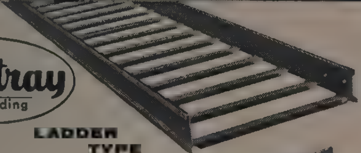

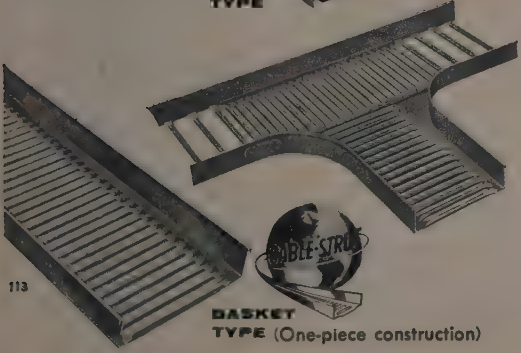

Globe's two types of cable trays, one a ladder type and the other a basket type, to support cables, wiring and tubing have become increasingly popular because they can be used INTERCHANGEABLY at any given location depending on the type and weight of the cables to be suspended. The advantages of each type tray can be used to the fullest. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is used for the support of communication wire, instrument tubing and control cables in automation applications.

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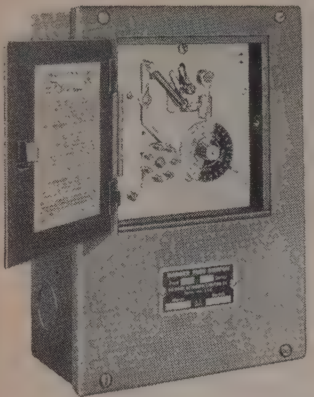

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- Reliance assures full scale quality at competitive prices

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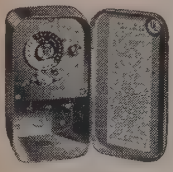
Featuring rugged construction, the Badger has *Dura-treated* copper contacts with pressure type terminals. Heavy non-ferrous gears run with steel pinions. Heavy-duty synchronous motor for indoor or outdoor installation. NEMA standard cabinets, flush or surface mounted. Vernier time set. Optional features include omitting device, extra trippers and one-hour dial.



MODEL 400

Reliance also manufactures a full line of general purpose time switches. These include the versatile 30 amp. Model W and the budget-priced 40 amp. Model 400. Model W is available in 7 standard types. Silver contacts. Non-ferrous gears run with steel pinions. One piece, deep drawn steel cabinet with hinged cover. Combination knockouts. One or two circuit control. Model 400 has all the convenience features of higher priced models.

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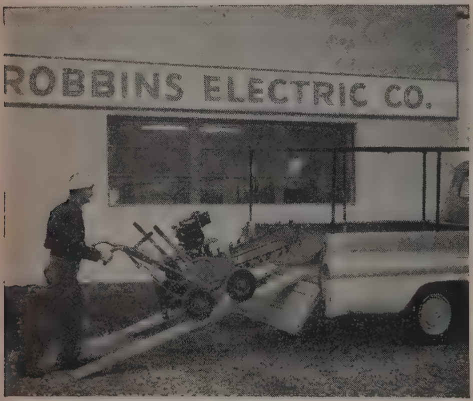

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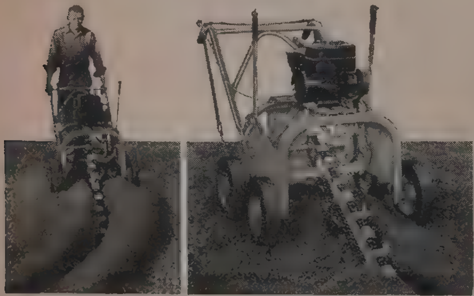

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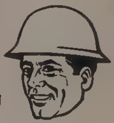

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11.0 Signal

tems. However, manufacturer's recommendations should be consulted for outlet boxes and the coordination of power-supply connections for this particular system.

Details of the wiring system should be shown on a riser diagram with the plans.

11.96 Equipment

Furnish and install a closed-circuit video system complete with equipment as listed herewith and all connecting cords, connectors, wiring, outlets and raceway systems as shown on the riser diagram of the electrical drawings.

Equipment shall be as manufactured by (name of manufacturer) and shall consist of: (list by quantity, name and catalog number, television cameras, monitors, receivers, supporting devices, controls, cable assemblies, auxiliary equipment, and other associated components.

11.97 Wiring

Receptacles for camera connection shall be (catalog number) receptacles in . . . plates.

Receptacles for monitor or receiver connection shall be (catalog number) receptacles in . . . plates.

Conductors shall be (type and size) coaxial cables as made by (manufacturer's name).

Raceway systems shall be . . . conduits as shown on the riser diagram and shall be of the same make and quality as specified elsewhere in this specification for power wiring.

CODE PROBLEMS discussion at Illinois Chapter, IAEI meeting continues in this post-session huddle between Joseph Crosno, Corn Belt Electric Co-op, Bloomington, Ill.; and R. L. Beasley, Coles-Moultrie Electric Co-op, Mattoon, Ill.

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New Westinghouse Dry-Type General Purpose Transformers with Rezildur

Westinghouse dry-type EP and EPT transformers stay on the job year after year, handling normal loads and unpredicted overloads with ease.

These transformers are protected by Rezildur,* an outstanding insulation system developed by Westinghouse research. Reliability of the Rezildur insulation system has been thoroughly established using the new proposed AIEE thermal life evaluation test (picture below). The result is transformers offering durability, long life and guaranteed performance.

Dry-type EP and EPT transformers are the smallest, lightest, quietest designs you'll find . . . surprisingly fast and easy to install indoors or out in practically any position. Low cost, too. Ratings are 25, 30 kva and below, single and three phase, 600 volts and below; 15 kva and below, single and three phase, 5,000 volts and below. Your nearby Westinghouse representative has full details. Or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

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Thermal life of a transformer is accurately determined by this new proposed AIEE test which makes an accelerated life evaluation. Results have conclusively established the reliability of Rezildur-insulated EP and EPT transformers over a long field life.

Westinghouse EP and EPT dry-type transformers with Rezildur insulation are Underwriters Laboratories, Inc., approved and meet NEMA standards.

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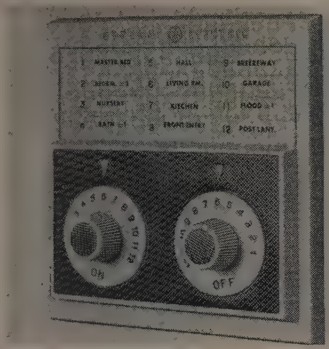
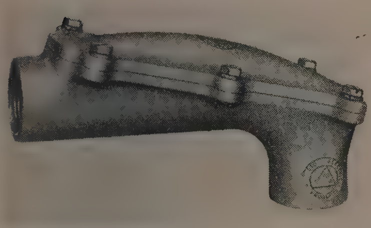


L-V Switching (1)

A new development in low-voltage switching makes the G-E remote-control wiring system more flexible and adaptable for residential, commercial and industrial installations. Relay centers are available with interchangeable, partially pre-assembled components for either the standard or new G-E plug-in type relays. Wall switches are available in three styles: dual pushbutton design, a new locking switch that requires a special key to operate, and a trigger style switch. New sculptured 12-position master-selector switch permits turning lights and appliance outlets on or off all over the house. Pilot lights illuminate names of rooms or areas where lights are on.

General Electric Co., 90 *Hathaway St., Providence* 7, *R. I.*



Pulling Elbows (2)

Newly designed Type ELBD pulling elbows are designed for the wiring of motors, panelboards, circuit breakers and similar equipment in hazardous areas. The elbows are explosion-proof and dust-tight, for Class 1, Group D, and Class 2, Group E, F and G locations. The large chamfered wiring chamber has a roller at each end over which large-sized or stiff, lead-covered conductors slide easily into and out of the hub without damaging the insulation. The reversible dome cover bolts in either direction. Elbows are made of heavy malleable iron, with galvanized finish. The 1- and 2-in. sizes are without rollers. The 2½- to 4-in. sizes have rollers. Bulletin 12-25A is available.

Appleton Electric Company, 1701-59 *Wellington Ave., Chicago* 13, *Ill.*

Heating Equipment (3)

Several new products have been added to this line of residential electric heating equipment. They include: a 3-ft-long baseboard section rated at 750 watts; a combination thermostat-switch-outlet section; and a wood dummy baseboard section. The 3-ft-long section incorporates all the advantages of the 2-ft baseboard sections. It is available in 120-, 208,- 240-, or 277-volt ratings. It is rated at 750 watts and provides 2560 Btu per hour per section.

The combination thermostat-switch-outlet section is 9½ in. long and contains a standard heating thermostat and a 240-volt outlet for use with room air conditioners. A summer-winter selector switch permits switching from heating to cooling. Outlet for cooling is rated at 12 amps; heat control is rated at 20 amps.

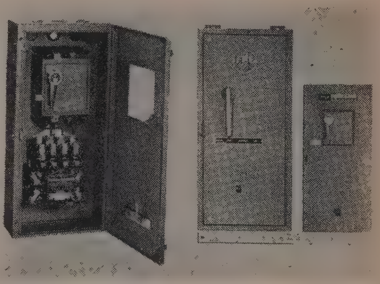
Wood dummy baseboard sections come in 4½ ft long lengths and can be cut with hack saw to provide "wall-to-wall" baseboard.

Westinghouse Air Conditioning Division, Staunton, Va.

Service Equipment (4)

Ten choices are now available in this line of 200-amp series-connected main pullout fusible service equipment. The main pullout may control as many as four branch pullouts and up to 32 plug-fuse branch circuits. In addition to the 200-amp main pullout, there is one 60-amp and two 30-amp pullouts also. These in turn can control either 20, 24, 28, or 32 plug-fuse branch circuits. Main pullout and branch pullouts are arranged in one enclosure. A single door provides access to all pullouts and plug fuses.

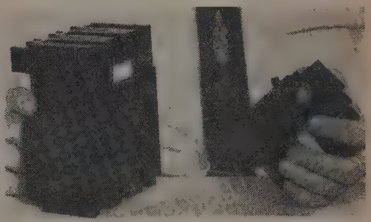
Murray Manufacturing Corp., 1250 *Atlantic Ave., Brooklyn* 16, *N. Y.*



Motor Starters (5)

A new line of combination motor starters features ultra compact size as well as circuit breakers with rotary handles. For use in industrial applications, where a single motor machine is involved, the unit combines in a single enclosure, branch circuit protection and disconnection, and motor starting and motor running overcurrent protection. The smallest unit in the line is 5 in. deep, 8¼ in. wide and 17¾ in. high. They are available in a variety of units and types, with starters ranging from NEMA 0 through 3, enclosures NEMA 1 and 12, and reversing and non-reversing.

Federal Pacific Electric Co., 50 *Paris St., Newark* 1, *N. J.*



Circuit Breakers (6)

New 100-amp 2- and 3-pole molded-case circuit breakers for use as main breakers have been introduced. Designated EQ-P (for plug-in connection) and EQ-B (for bolt-in connection), breakers can replace much larger E-frame breakers which formerly were needed when 100-amp ratings were required in residential, commercial and light industrial applications. Breakers incorporate expanded handles which run the full width of breaker. A complete line of small size breakers in ratings from 15 through 100 amps continuous-current at 120 and 240 volts ac; 1-, 2- and 3-pole units, and several special breakers are available.

I-T-E Circuit Breaker Company, Philadelphia, Pa.

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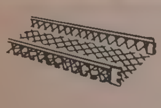
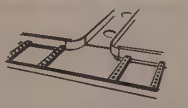
Qualified Cope field men are prepared to give on-the-spot assistance and advice. Let your Cope man show you why Cope's shallower duct design, easy to handle components and simplified service fittings speed underfloor installations for power, telephone and intercom wiring.

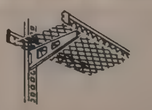
Cope Standard and Double-Capacity Underfloor Duct for conventional slab construction ... Cope Headerduct for coordination with cellular floor construction—all three provide maximum service availability and flexibility of outlet locations to meet specific needs.

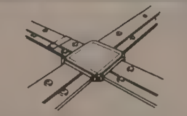
A complete line of Dreyfuss designed service fittings are readily installed with Cope Underfloor Duct Systems ... can also be used to modernize existing systems.

Contact your Cope man—or write direct for detailed data on Cope Underfloor Duct Systems. FORMERLY SPANG—NOW MADE BY COPE, THE LEADING MANUFACTURERS OF CABLE SUPPORTING SYSTEMS.


COPE WIREWAY

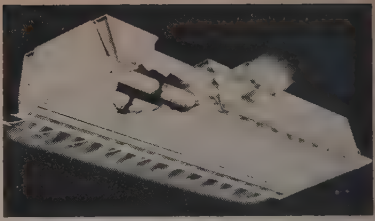

LADDER AND CHANNEL


SYSTEM SUPPORTS


UNDERFLOOR DUCT

COPE DIVISION ROME CABLE CORPORATION
Collegeville, Pennsylvania Dept. G

A CHOICE OF WIRE AND CABLE SUPPORTING SYSTEMS



Combination Fixture (7)

A new combination fixture, called Ventro-Lux with Anemostat air diffuser, provides light, heat, cooling and ventilation. The troffer is combined with a high-capacity air diffuser. Air is directed horizontally along the ceiling for even distribution. The Ventro-Lux lighting and Anemostat air diffuser units are designed together assuring a low silhouette, 6 in. or less. The two units are installed separately. The fixture is recommended for installations in offices, stores, banks, hospitals, and schools.

Curtis AllBrite Lighting, Inc., 6135 W. 65th St., Chicago 38, Ill.

Wireholder (8)

A new "oversize" pipe-mounting wireholder for use on 3- and 4-in. pipe. Identified by Catalog No. 6913, it is constructed like the 6912 "Universal" wireholder; heavy-gauge, hot-galvanized hardware and copper-bail reinforced porcelain.

Porcelain Products Co., Carey, Ohio

Time Control (9)

A new time control combines mechanical switching with light-sensitive control. The unit was designed for the control of entrance lighting, outdoor protective lighting for schools, churches, industrial buildings and lighting for parking lots, industrial yards, and shopping centers. With the new control, lighting comes on automatically, as needed, regardless of season. It goes off, automatically when it is no longer desired, at any pre-set hour. Available in double-pole and single-pole models, fully rated for incandescent lamp loads, the DP model No. 9200 offers 4,000 watts per pole; the SP model No. 9100SK is rated at 1,000 watts. With the 9100SK, operation can be skipped on Sundays or any pre-selected days of the week automatically.

Tork Time Controls, Inc., Mount Vernon, N. Y.

Wire Puller **(10)**

A new wire puller handles runs of any distance. The rope or cable is not stored in the pulling drum, instead the drum automatically takes up, then pays off the rope. It delivers a constant 20 to 1 power ratio throughout the entire pull. It is designed for use with non-conductive Jet Line Poly Rope. It works well in any type conduit: metal, plastic, fibre and aluminum. It grips on the pipe, so pull can be started anywhere along the run.

Jet Line Products, Inc., 615 Fugate Ave., Charlotte 5, N. C.

Wire Stripper **(11)**

A new all-steel wire stripper strips insulation from both stranded and solid wire. A single squeeze on handles, strips wire clean. An arm automatically drops down to hold jaws open and prevent crushing of stranded wire. After wire is removed, a second squeeze releases arm and stripper is ready for next wire. Three sizes include: Model AS-02 for Nos. 22-10 wire, Model AS-2 for Nos. 18-10 wire, and Model AS-3 for Nos. 14-8.

Holub Industries, Inc., Sycamore, Ill.

Luminaires **(12)**

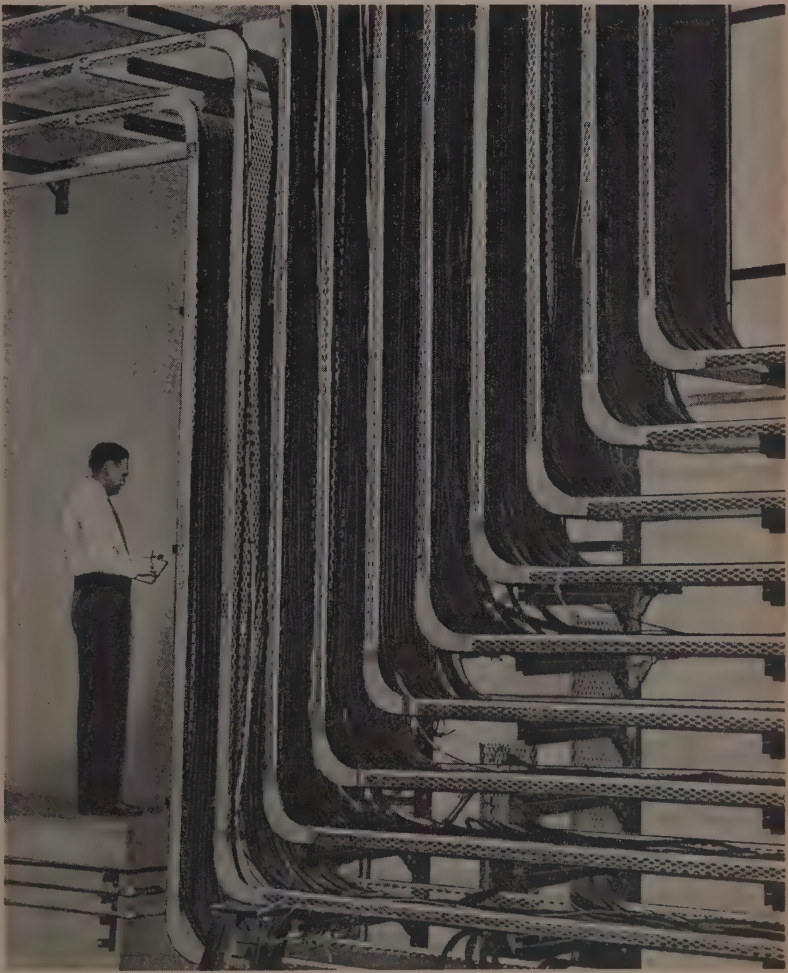
New fluorescent sign-lighting luminaires are now available. They can be top or bottom mounted, individually or in continuous rows. Three lengths of fixtures are available—4, 6 or 8 ft. Either 800-ma or 1500-ma high-output lamps can be used. A unit called Sataliner is recommended for locations where the best possible illumination is needed. Fixtures have a specular reflecting surface of Mylar, backed by aluminum. A weatherproof, transparent-plastic hinged cover is supplied with units which are to be bottom mounted. The Adliner fixture has an extruded aluminum reflector with a permanent baked-on enamel finish. A protective plastic cover which slides into grooves at bottom edge of reflector is available if fixture is bottom mounted.

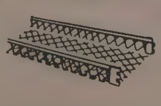
Lighting Div., Westinghouse Electric Corp., Edgewater Park, Cleveland, Ohio

CAPACITY TO CARRY
A FULL CABLE LOAD...AND THEN SOME

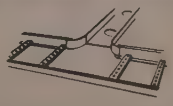
Just one section of 24″ wide Cope Wireway supports as many cables as 14 lengths of 4″ conduit. Space-saving Cope Wireway installations offer ample cable supporting capacity to handle the heaviest distribution loads—provide needed room for additional cable as load demands increase!

Cope systems are easy and inexpensive to install, even in the most cramped quarters. Ask a Cope man about the complete line of Cope cable supporting systems for every distribution requirement—or write direct for detailed data. SOLD ONLY THROUGH AUTHORIZED ELECTRICAL WHOLESALERS.





COPE WIREWAY



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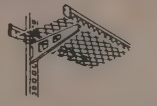
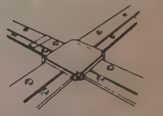


SYSTEM SUPPORTS



UNDERFLOOR DUCT

COPE DIVISION ROME CABLE CORPORATION
Collegeville, Pennsylvania Dept. G

A CHOICE OF WIRE AND CABLE SUPPORTING SYSTEMS

Sound warning is advice to be heeded!

Signals, audible or visual, are quicker in action, are universally recognized and initiate *instant response.*

The sound of a siren literally cries

Danger—Emergency!

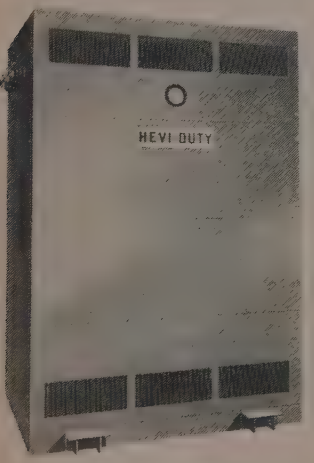
The startling flash of the Beacon Ray, its companion signal, provokes the same reaction visually.

FEDERAL has pioneered in visual and audible warnings, the *very best signals* available.

Write for more information—ask for Catalog #100.

FEDERAL SIGNAL SIGN and Corporation
13626 S. Western Ave., Blue Island, Ill.

QUIET TRANSFORMERS?
these decibel ratings speak for themselves —



in a *whisper*

Designed sound levels for representative sizes of standard Hevi-Duty dry type transformer.

SINGLE-PHASE		THREE-PHASE	
KVA	Decibel Rating	KVA	Decibel Rating
1.0	33	6.0	38
7.5	33	9.0	40
10.0	40	15.0	44
20.0	44	30.0	43
37.5	44	45.0	45
75.0	49	112.5	45
100.0	50	150.0	47

Write for Bulletins 100 and 200 for further details.

HEVI-DUTY
Dry-Type Transformers
Constant Current Regulators

B P
C

Hevi-Duty
Electric Company,
Watertown, Wis.

A Division of
Basic Products
Corporation

Catalogs & Bulletins

(13) Condulets and the National Electrical Code are discussed in Bulletin 2722, 60 pages, detailing the applications of condulets in hazardous locations. Crouse-Hinds Co.

(14) Socket Meter Covers. Bulletin covers transparent replacement covers for watthour socket meters. Busada Manufacturing Corp.

(15) Transformers. 36-page catalog describes line of single-phase, 3-phase and phase-changer dry-type transformers. Atlantic Transformer Co.

(16) Controls. Bulletin GEA-7316, 8 pages, describes line of definite purpose contactors and starters for air conditioning and refrigeration. General Electric Co.

(17) Generator Controls and Trans-O-Matic automatic transfer switches are described in 4-page Bulletin 1260. Lake Shore Electric Corp.

(18) Electrical Products. Twelve new products are announced in 36-page pocket-size catalog, including specifications and descriptive literature of line of wiring devices, fuse specialties, fastening devices and masonry drills. Holub Industries, Inc.

(19) Soldering Tips. Catalog 603 describes "Hexclad" and "Xtradur" lines of long-life iron-coated soldering tips. Hexacon Electric Co.

(20) Ballasts. Bulletin GEC-983Q, 24 pages, contains revised tables of prices and data for line of ballasts for fluorescent lamps as of December 1960 General Electric Co.

(21) High-Voltage Capacitors. 4-page Bulletin TPC-104 includes tables for the proper selection of the rating of standard capacitor units and their connection for a variety of system voltages. Line Material Industries, McGraw-Edison Co.

(22) Drill Extension. Bulletin 359, 4 pages, describes Extend-A-Bit tool for drilling between enclosed walls or through joists, installing conduit or EMT at the same time. Ability Electric & Mfg. Co.

(23) Current-Limiting Reactors. Bulletin GEA-976E, 16 pages, describes cast-in-concrete reactors for use on electric utility and industrial plant distribution systems rated 34,500 volts and below. General Electric Co.

(24) **Motors.** Brochure F-1971 contains technical data, illustrations and descriptions of new line of advanced-design right-angle worm-gear motors designated the U. S. Syncrogear, Type GW. U. S. Electrical Motors Inc.

(25) **School and Office Fixtures.** 4-page brochure describes Decathlon Series 21 school and office fixtures and contains specifications, candlepower distribution curves, coefficients of utilization, dimensions, and sketches of hanger arrangements. Litecraft Manufacturing Corp.

(26) **Elevator Motors.** Two new bulletins cover ac electric motors for elevator service. Bulletin 6400 describes single-speed elevator motors, and Bulletin 6401 covers 2-speed double-wound motors. Imperial Electric Co.

(27) **Lighting Standards.** 12-page catalog describes davit-style lighting standards to support the standard incandescent and mercury-vapor luminaries including the new, mercury-vapor and fluorescent luminaires. Pfaff & Kendall.

(28) **Synchronous Motors.** Bulletin 1100-PRD-253 describes line of heavy-duty, synchronous motors in ratings of 600 hp and up. Electric Machinery Mfg. Co.

(29) **Heavy-Duty Relays** for industrial and military application are described in Bulletin 20. Line Electric Co.

(30) **Floodlights.** Bulletin EFL-960 describes new series of five Intenso "Econoflood" floodlights. Appleton Electric Co.

(31) **Grounding Devices.** Latest information of NEC requirements most likely to affect the installation and operation of portable electric tools and equipment is contained in 8-page booklet entitled "Grounding Facts." The Arrow-Hart & Hegeman Electric Co.

(32) **Highway Sign Lighting.** Bulletin OLP-1023, 20 pages, discusses criteria for determining proper highway sign lighting, giving sketches and photographs and typical Fluoroflood fixture installations. General Electric Co.

(33) **Capacitor Banks.** Technical Bulletin TPC-103 shows a quick and accurate method of computing inrush current magnitude and frequency in shunt capacitor bank installations. Line Material Industries, McGraw-Edison Co.

(34) **Cellular-Floor Raceway.** Two-catalog portfolio Pub. C-7170 describes cellular-floor header system and floor outlets and fittings. General Electric Co., Conduit Products Dept.

but what does it cost INSTALLED?

Anchoring to masonry, a big part of "in place" cost, includes at least three items: anchors, drills, labor. The cheapest anchor, if it isn't right for the job, may be the costliest to install.

For an economical, effective installation, help yourself to The Rawlplug Company's 40 years of experience designing, manufacturing, testing, and using anchors and drills for fastening just about every type of fixture to every type of masonry. Because we make a full line of masonry anchoring products, we can and will advise you impartially.

Our masonry anchoring know-how is summed up for you in an interesting eight-page booklet, "Install It for Less." For a free copy, ask your local Rawlplug branch or distributor, or use the handy coupon. Before you start to put that unit in place, see how you can anchor it to masonry for the lowest cost INSTALLED.

RAWL

1921-1961
ANCHORING AND DRILLING
PRODUCTS FOR FASTENING
ANYTHING TO MASONRY

R-21

The RAWLPLUG Company, Inc.
212 Petersville Road, New Rochelle, N.Y.

Please send a FREE copy of "Install It for Less" to:

Name..............................

Title..............................

Company..............................

Address..............................

....

How Circle exceeds the specs to give you...

MAXIMUM LONG TERM STABILITY

Most ordinary products generally manage to *meet* specifications. The quality product is recognized by the way it *exceeds* them.

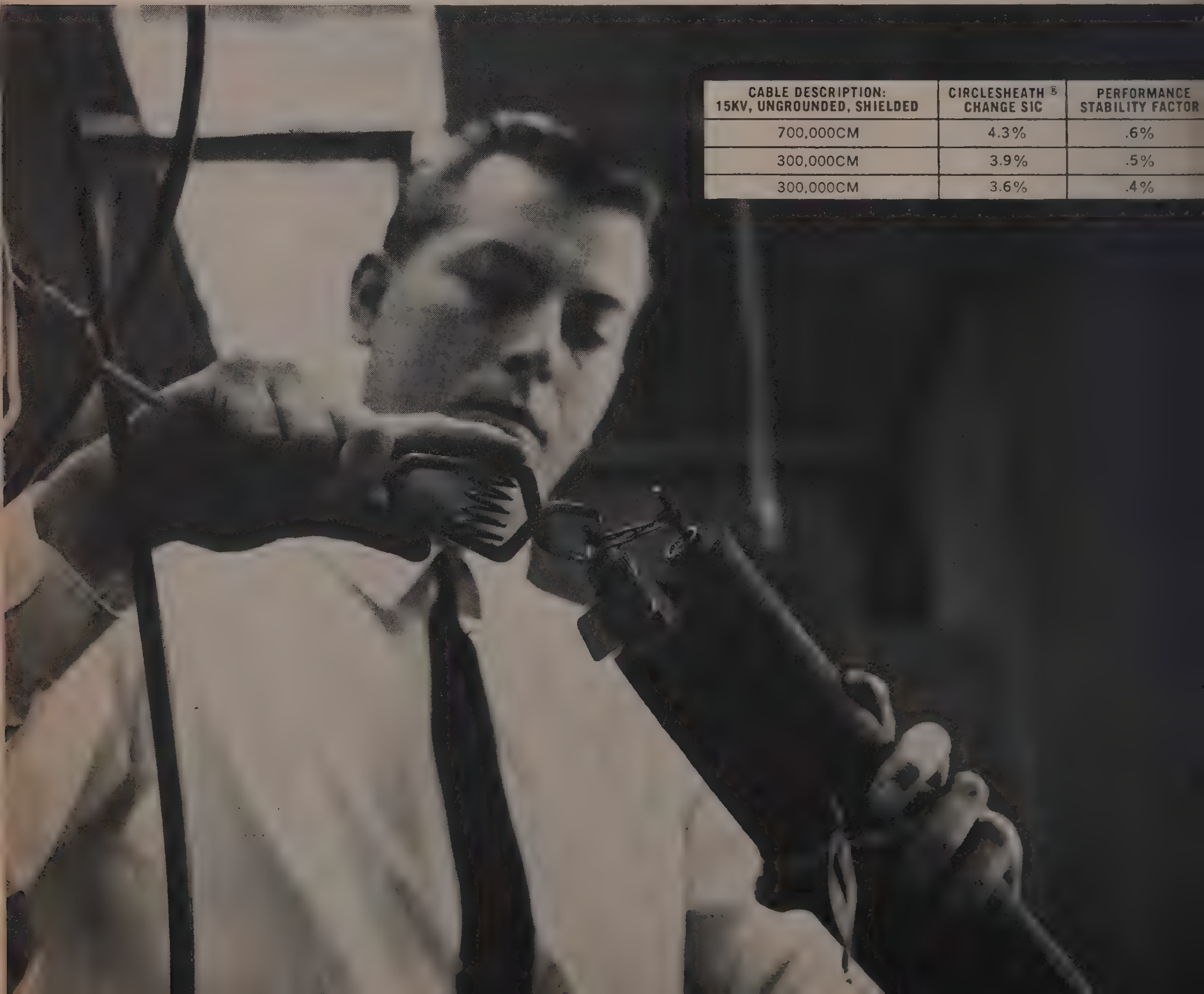
Take, for example, Circlesheath Type RR Power Cable and the important IPCEA-NEMA 60 cycle water absorption test. Requirements call for immersion in water for 14 days with maximum SIC change and stability factor of 5% and 1% respectively.

The table below clearly indicates Circlesheath superiority — not only after 14 days submersion but after *two years and ten months in a test that was originated in September 1958!*

Long term stability is only one of the many ways Circlesheath exceeds specs to give users maximum performance. For complete reliability, specify Circle on your next job — there's no finer power cable made.

CIRCLE WIRE & CABLE CORP.
SUBSIDIARY OF **CERRO CORPORATION**

PLANTS: Maspeth and Hicksville, N. Y. **SALES OFFICES & WAREHOUSES:** In all principal cities.
Rubber Covered Wires & Cables • Varnished Cambric Cables • Plastic Insulated Cables • Neoprene Sheathed Cables • "CIRTUBE" EMT



CABLE DESCRIPTION: 15KV, UNGROUNDED, SHIELDED	CIRCLESHEATH® CHANGE SIC	PERFORMANCE STABILITY FACTOR
700,000CM	4.3%	.6%
300,000CM	3.9%	.5%
300,000CM	3.6%	.4%

Reader's Quiz

QUESTIONS from readers on problems of industrial equipment, installations, maintenance and repairs. Answered by electrical maintenance engineers and industrial electrical contractors out of their experience. For every question and every answer published we pay $5.00.

Motor-Winding Resistance Tests

QUESTION H39—There are a number of cases where it is desired to measure the resistance of the motor winding while the motor is energized. One case that occurred in our plant was where the variation in temperature of the motor winding was to be recorded while the motor was operating. I would appreciate it if someone could advise the best method of doing this. The motor in question is a ½-hp 115-*volt, single-phase motor.—H.H.S.*

ANSWER TO H39—If the motor must be kept operating continuously without shutting it down to take a resistance measurement, the simplest method would be to have the motor fitted with resistance coils placed in the stator-slots or wedged into coils space where desired. This is a usual method employed by manufacturers, and testing devices are readily available with suitable temperature indicating equipment. The motor manufacturer could supply such equipment. It is generally known as "hot-spot" indication and is in use on many large units.—C.O.D.

ANSWER TO H39—Unfortunately, there is no simple method of measuring the resistance of a motor winding while the motor is energized. However, the resistance value can be obtained and very successfully, too.

A thermocouple should be placed on a relatively hot spot of the motor winding. Then the resistance should be measured at room temperature. The change in temperature can be utilized to calculate the resistance under any circumstance.—J.M.

ANSWER TO H39—You can glue a thermocouple or resistance coil next to the winding, and then take readings with a recording or plain ohmmeter or bridge.—H.S.

Medium-Voltage Motor Selection

QUESTION J39—We are planning on installing some large motors in a section of our plant and have a 2.4 kv available, but can also obtain 4160 volts for these motors from available transformers. I am interested in knowing what the considerations are in deciding which of these two voltages to use.—R.E.B.

ANSWER TO J39—The most important consideration in selecting the voltage for motors is economy. By using the voltage of your incoming line, or the generator voltage of your own power house, you eliminate and save the purchase price, installation cost and all maintenance expenses of the transformer and its switching and protective devices.

If the voltage must be changed, the most economic system will be to use that voltage where you have sufficient available spare capacity on existing transformers.

Speaking of economy, you should also consider future requirements and select a system that lends itself for expansion. An important consideration is also, the available short-circuit capacity of your 2.4-kv and 4.16-kv system; the switchgear must be rated accordingly.

The 4.16-kv system will be especially advantageous if your large motors are classified at 1000 hp or more.—J.A.

NEW OFFICERS of the Minnesota Electrical Assn., Inc., for 1961, elected at the 24th Annual Upper Midwest Electrical Conference at the Leamington Hotel, Minneapolis, February 19-21, were (l to r): Robert De War, De War Electric, Fairmont, vice president; Stan Berquist, Berquist Electric, Litchfield, president; Le Roy Hauer, Hauer Bros. Electric, Little Falls, secretary; and Louis Kasperke, Minnesota Valley Electric, Lesuer, Minn., treasurer.

ANSWER TO J39—A decision for this problem should be considered from the standpoint of practical application in addition to the matter of cost.

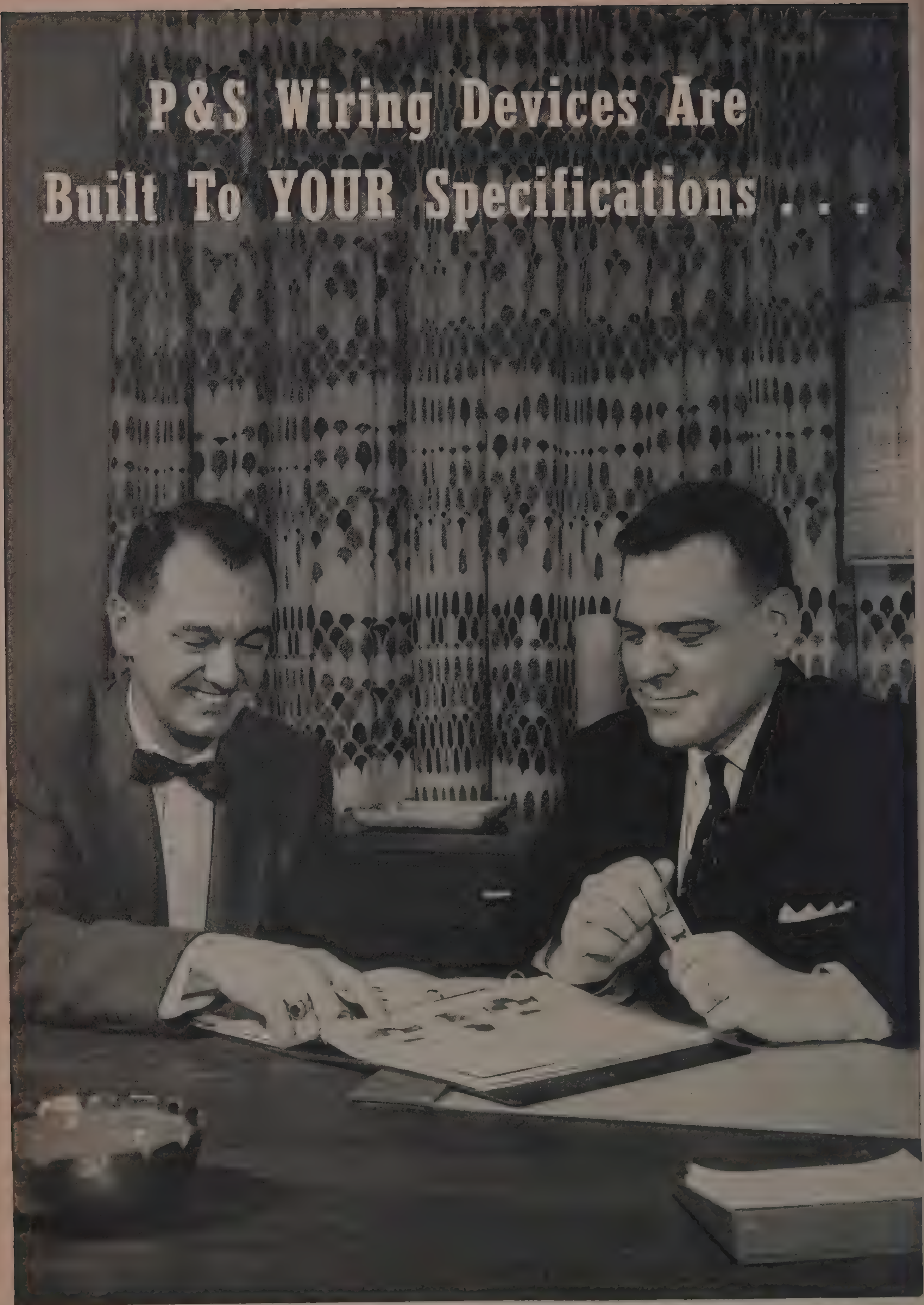
The relative cost of 2.4- and 4.16-kv motors is not very different but if there are a few of the higher voltage rating, the question of repair and maintenance should be considered, taking into account the relatively higher cost of spare coils. The rating of larger motors in horsepower is not given and this should be taken into account or in the layout cost and its feeder connection.

It follows that unless a very material saving is indicated in initial cost, the addition of a new motor differing in voltage from the equipment now in service should be avoided.—C.O.D.

ANSWER TO J39—The first consideration should be transformer capacity at 2400 volts versus capacity of 4160-volt transformers. This must be applied as the criterion of proper performance of the motors to be connected. Actually this means, "Is there sufficient kv available for good starting?" Coupled with this should be a size and power-factor analysis of the load already connected to these transformers, and a study of possible adverse effects when the large motors are started.

The difference in size and weight of the motors at 2300 volts or 4000 volts will not be much, but is worthy of consideration in the light of available space and floor loading. The cost of necessary disconnecting devices at 4160 volts versus the cost of disconnecting devices at 2400 volts merits some study as does the cost differential of motors.

Cable cost is another factor which should be considered, keeping in mind both copper and insulation; less copper at 4160 volts, less insulation at 2400 volts. Interchangeability with motors presently installed or in stock as spare should be considered if production time is important. Along with this, spare-parts inventory for both motor and control components should be studied if the new motors and control will differ greatly from those already in service.—G.M.O.


P&S Wiring Devices Are
Built To YOUR Specifications . . .

Dependable Operation
Rugged Durability
Trouble-Free Service

P&S ROCKER-GLO SWITCH

Available in Despard interchangeable type, Despard type strap mounted, and strap type with narrow rocker for tumbler switch plates. A specification grade switch, 15 and 20 Amps. 120/277 volts AC.

P&S SUPER AC SWITCHES

Extra large terminal screws. Extra-heavy silver alloy contacts . . . mounted *upright* at point of least vibration. Can be used at *full-rated* capacity for inductive loads. Back or side wired. Available in 15 or 20 Amp. types.

P&S 3-WIRE GROUNDING

Rugged 20 Amp, 125 Volt 3-wire grounding outlet especially designed for use with the new NEMA standard 20-Amp, 125 volt grounding caps. May also be used with 15 Amp, 125 Volt grounding caps or regular ungrounded parallel blade caps.

P&S TURNLOK

Designed for trouble-free service under toughest conditions. Available in 10 and 20 Amps, 2-, 3-, and 4-wire types: receptacles, connectors and caps. All P&S TURNLOK devices have extra large head binding screws and ample wireways for quick, easy wiring.

For more information about the complete line of P&S "Performance Specified" wiring devices, write Dept. *ECM 561*

P&S PASS & SEYMOUR, INC.
SYRACUSE 9, NEW YORK

60 E. 42nd St., New York 17, N.Y. 1440 N. Pulaski Rd., Chicago 51, Ill. In Canada: Renfrew Electric Co., Ltd., Toronto, Ontario

Can You Answer These QUESTIONS?

QUESTION S39—In my work I am often confronted with the problem of long underground conduit runs, mostly for 480-volt branch circuits for motors from 3 hp to 200 hp. The runs are sometimes so long or difficult, that intermediate pull boxes must be installed. For this purpose, I would appreciate getting a simple formula or table based on practical experience to determine the maximum length of pull under the following conditions:

Conduit run to be rigid steel, one 90° vertical elbow at each end of the conduit run. Radius of elbow is two times the minimum radius specified in NEC Table 346-10; horizontal bends to be long sweeps; cables to be Type RHW or THW.

For big cables and critical conditions, I use the lengthy method given in a handbook.—J.A.

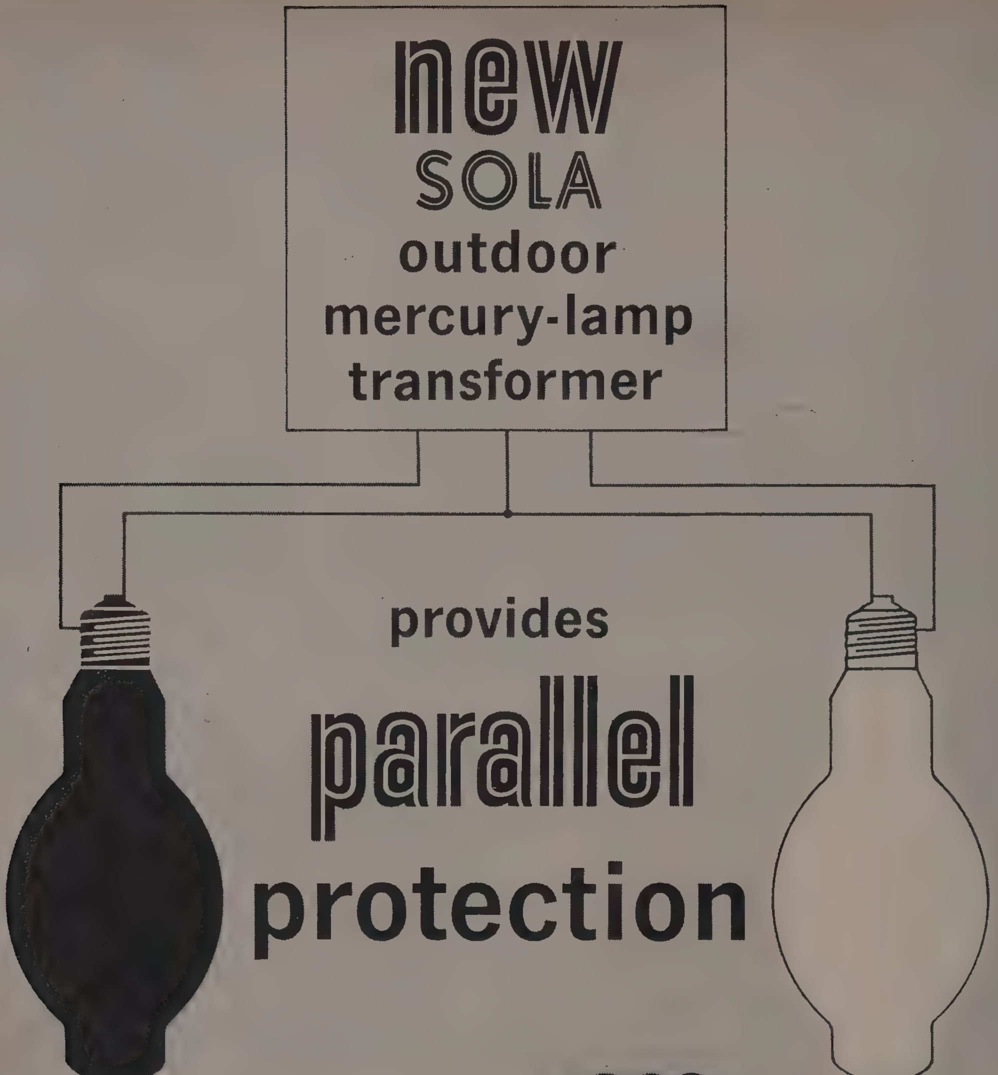
QUESTION T39—I have a question regarding use of mineral-insulated cable, single-conductor type. From calculation or experience, can you tell me if appreciable or harmful, induced currents or heat rise in the sheath will result from the use of the larger size cables on alternating currents?—D.L.

QUESTION U39 — Being maintenance foreman of a large printing plant, I am plagued with static in the letterpress printing, offset printing, folding and ruling machines.

If any readers are familiar with the printing equipment or any others have static problems, I would be grateful if someone could suggest or diagram a homemade remedy for removing static.—C.W.P.

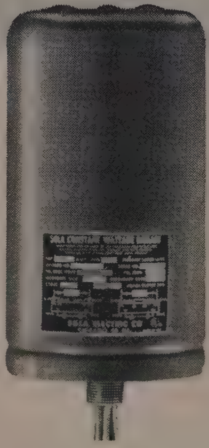
QUESTION W39—In our new installation, we have sensitive electronic instruments such as hysteresigraph, X-ray diffractometers and others. We are experiencing inconsistent readings with these instruments ever since we moved into our new building. We were told that stray, building ground currents cause this erratic operation. Is this so? If so, what can we do to eliminate this condition?—J.A.M.

PLEASE SEND IN YOUR ANSWERS BY JUNE 15



new SOLA outdoor mercury-lamp transformer

provides parallel protection



. . . plus constant-wattage stability!

Here's the big improvement you've waited for in *mercury lamp ballasting:* a really stable, *parallel-type,* constant-wattage, *2-lamp* transformer. Even if one lamp burns out, this new SOLA transformer keeps the other shining steadily.

And SOLA's *constant-wattage performance* protects both lamps and wiring against surge current . . . forestalls flicker by providing complete electrical independence between paired lamps; also, automatically compensates for line-power fluctuations. And the modest starting demand of SOLA constant wattage allows you to install more fixtures per circuit without having to step up wire sizes. The cost advantages are obvious in such installations as: parking lots, shopping centers, service stations, and dock areas.

Contact your SOLA representative for details on new 2-lamp outdoor constant-wattage MV transformers, as well as the other indoor and outdoor alternative units. Or write for information, mentioning *parallel MV outdoor transformer.*

- "Paralleling" ends double lamp-outages
- Exclusive constant-wattage design holds lumen output within ±1% for line-voltage changes as great as ±13%, assuring full-rated lamp life
- Prevents "drop-out" since input voltage must fall 30% below nominal before lamps extinguish
- Inherent protection against open or short-circuited lamps
- U.L. listed
- Available for 115, 208, 230, 277, 460 and 575-volt input

SOLA

A DIVISION OF
BASIC PRODUCTS CORPORATION

B P
C

SOLA ELECTRIC CO.
Busse Road at Lunt,
Elk Grove Village, Ill.
HEmpstead 9-2800
IN CANADA, Sola-Basic
Products Ltd., 377 Evans
Ave., Toronto 18, Ont.

Questions on the Code

Answered by:

B. A. McDONALD, *New York Board of Fire Underwriters, Rochester, N. Y.*
B. Z. SEGALL, *Consulting Electrical Engineer, New Orleans, La.*
R. E. WARD, *Chief Electrical Inspector, Insurance Department, State of Tennessee, Nashville, Tenn.*

Area Above Commercial Garage Pit

Q. *How would the area directly above (within 18 in. of floor level) a pit in a commercial garage be classified?—D.P.*

A. In my opinion, the area within 18 in. above the floor level above the pit would be Class I, Div. 2. Paragraph 511-2(c) is included to merely emphasize the fact that, in general, the pit in this location may also be classified as Div. 2. But under certain circumstances as stated in this paragraph, viz., " . . . individual unventilated pit or depression" the code enforcing authority may judge it to be Div. 1.—B.Z.S.—5/61/1

Plug-Fuse Voltage Ratings

Q. *In a factory building being supplied with a 480Y/277-volt 3-phase electric system that will serve lighting, is it permissible to use a panelboard of the plug-fuse Edison-base type?—R.A.*

A. No. Under Paragraph 240-20 (a), Classification, plug fuses of this type shall be classified at not over 125 volts, 0 to 30 amps. From the above you can see your voltage exceeds the permitted rating for plug fuses.—R.E.W.—5/61/2

Grounding Connection Accessible

Q. *Section 250-112 of the 1959 Code, states: "Where practicable the point of attachment shall be accessible."*

The question I have is: Concealing of ground clamp in wall. The water comes in a ¾-in. copper tube inside the wall. I grounded the system where it entered the building, but the inspector required me to move the connection to a ⅜-in. chrome-plated nipple underneath the lavatory. If I interpret this article correctly he is not taking the word practicable into consideration, but leaving it out, thus changing the meaning to mandatory. I feel that this is not using good judgment.—W.D.W.

A. According to the provisions of Section 90-7 of the 1959 Code, the responsibility for making interpretations of Code rules is delegated to the administrative authority supervising the enforcement of the code. When code rules are phrased in terms of "where practical," the inspector has the responsibility for deciding the question on the basis of existing field circumstances. In the case presented, it is difficult to question the judgment of the inspector, in the absence of the various details involved. If there is a water meter on the property, it must be accessible for the purpose of recording the water used. Is there any good reason why the grounding conductor should not be run to the street side of the water meter, a method which appears to be preferred by the code? If there is no meter, there must be an accessible valve regulating the flow of water. Is there any good reason why the grounding conductor should not be run to the accessible valve? Such are the questions which appear to be involved. It is difficult for me to visualize a situation in a dwelling occupancy where the conditions are such that one finds it necessary to conceal the grounding connection to the electrode.

One of the most vital elements of a wiring design is grounding. It safeguards the hazard of lightning and faults on the distribution system which could cause high voltage to be imposed on the interior wiring. The most effective grounding circuit is the one which provides a short and direct path through the electrode to the ground outside the building. As covered by Section 90-1(b) it should be maintained. This involves periodic inspection, and the point of attachment to an electrode should be accessible for inspection. Your statement indicates that a lightning discharge would be brought into the building to the lavatory before it found a path to ground through the water pipe electrode. To me, this could present a hazard since lightning might find an arcing path to ground through the drain pipes. If this happens, some of the plumbing fixtures, such as the trap may be destroyed. The connection to the ⅜-in. nipple also is questionable since usual practice dictates the use of a minimum ½-in. water pipe electrode. The inspector who approves the installation assumes the responsibility for safe performance. One should not be too critical of his findings when a question of practicability is involved. He may find himself in a difficult position to defend his position when a serious fault occurs.—B.A.McD.—5/61/3

Type S Fuse Adapters

Q. *Within the last few days I purchased some fuseholder adapters for Type S fuses. I was informed that the Type S adapters were only made in two sizes, and that in the larger size, one of the following could be used—20, 25 or 30 amp. It has been my understanding that the adapters were of such construction that a 30-amp size would not make contact in a 20-amp adapter.*

Is the above statement true with reference to only two sizes of Type S adapters?—A.W.

A. Yes. Your question is covered in the NEC under Section 240-22, "Plug Fuses and Fuseholders of Type S." Under paragraph (a) of this section, Type S fuses are classified at not over 125 volts; 0 to 15 amps, 16 to 30 amps. You will also note under paragraph (b) that fuses of 16- to 30-amp classification shall not be usable with fuseholders or adapters of the 0- to 15-amp classifications.

Your attention is called to the fact that we do have fuseholders with a different classification or a different breakdown in classification other than required by the NEC. As an example, in the UL Electrical Construction Materials List, under the heading "Fittings for Fuseholders," Bussmann Manufacturing

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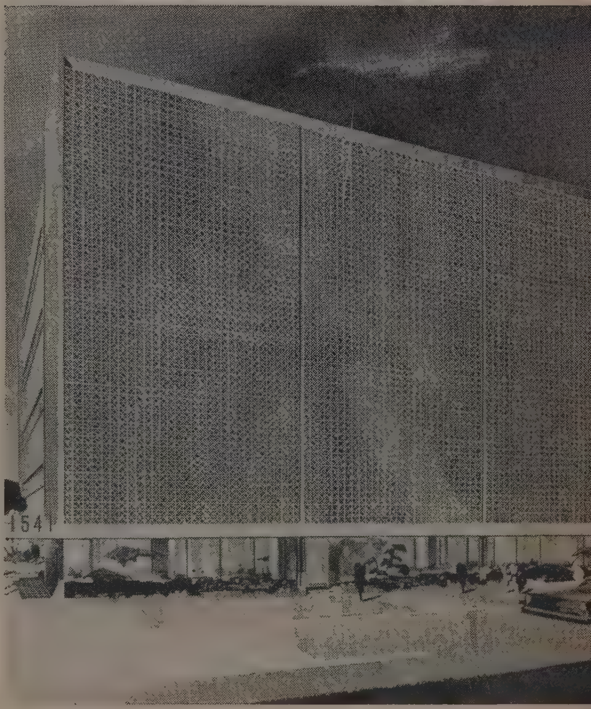

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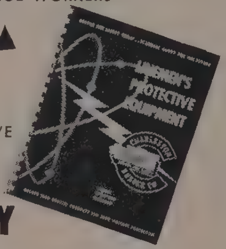

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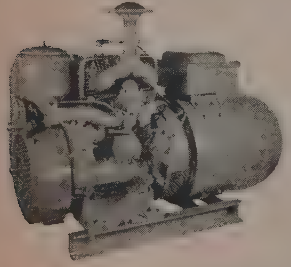

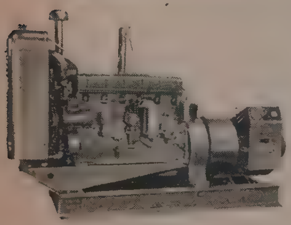

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Division, McGraw-Edison Co., has adapters designed to permit use of Fustats in plug fuseholders. This company has adapters listed for at least ten different classifications. In other words, if you use a Fustat adapter of their make for a certain classification, you will not be able to insert a larger Fustat than the adapter is designed to accommodate. The same company has Type S fuseholders so designated to accommodate fuses rated 7 to 15 amp and 16 to 30 amp, and the marking is "Fustat Type S." On the other classification, as is mentioned above, the marking is "Fustat and ampere rating."

According to NEC Panel No. 4, they now have a proposal before them for consideration in the next edition of the National Electrical Code that would change the classification for fuseholders. This proposal would add another classification from 16 to 20 amps, and if adopted, I am sure that it will meet with wide approval by most electrical inspection authorities. — R.E.W.—5/61/4

Wireway Fill

Q. *Table 1, Chapter 9 allows as many as 208 No. 12 wires in a 5-in. conduit. Table 4 allows 40% fill of the internal area of conduit or tubing. Paragraph 362-5 limits the number of conductors to 30 in a wireway, and also limits the fill of wireways to 20% of any interior cross-sectional area.*

Why are wireways limited to 30 conductors and the fill to 20% of any interior cross-sectional area?

Also, why is it that you are allowed more conductors and a greater fill in conduit and tubing than allowed in wireways?—A.F.G.

A. The exact answer to this is unknown to the writer. It is possible that the printing of this question and answer will elicit further discussion from our readers.

The fact-finding investigation made by the Underwriters' Laboratories, Inc. under the sponsorship of the American Iron and Steel Institute was made to determine if more than nine conductors could be safely installed in a raceway. Furthermore, this investigation was made to determine what derating factors should be applied if the installation of more than nine conductors in a raceway could be permitted.

As a result of this investigation,

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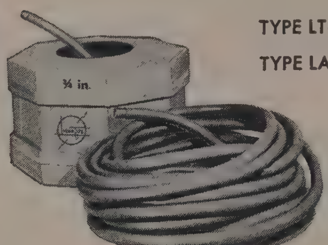

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the report recommended the installation of more than nine conductors in a raceway. At this point it should be pointed out that the code definition of a raceway includes a wireway. This report presented in detail the derating factors to be applied and basically these factors are shown in the table in Note 8 to Tables 310-12 through 310-15 in the code.

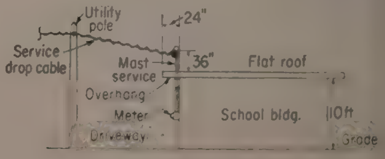
Another important recommendation made by this report was that "a 40% fill be made to apply to all steel raceways." From this it may be stated that the 40% fill was recommended also for wireways. As you note in your query, the code requirements did not follow this recommendation and continued the old requirements of a 30-conductor and 20% limitation.

It is important, however, to note that the derating factors do not apply to these conductors in wireways. Because of this it is necessary to establish this 30-conductor limit to prevent overheating of the conductors in the wireways.

It should be pointed out that as a practical application, it will most probably be found that full advantage cannot always be taken of this greater permissible conduit fill. From an economical standpoint, the fact that we must apply such large derating factors when installing these larger number of conductors, it may be found that more efficient use may be made with these same sized copper conductors from a current-carrying-capacity standpoint, if more smaller-sized conduits are installed.—B.Z.S.—5/61/5

Clearance Over Roof

Q. *A one-story school building with a flat roof requires a 200-amp 115/230-volt 3-wire single-phase electric service. The roof overhang extends away from the wall 24 in. In order to maintain proper clearance of service conductors over a driveway, it is necessary to use a mast-type service extending through the overhang of the roof. There will be no means of reaching the roof except by a ladder. Triplex cable of the multiple-conductor type will be used as the*



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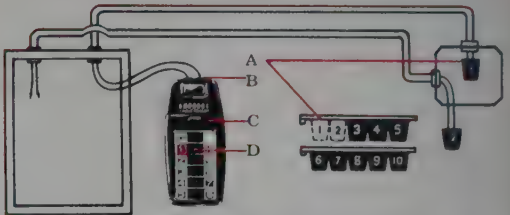

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service drop, which will extend from the service pole to the mast of the service conduit. This cable will of necessity be above the 24-in. overhang of the roof.

What clearance shall I maintain between roof and drop?—W.H.R.

A. Your question concerns Section 230-24 of the NEC, and I am sure that you have reference to 230-24(a) which states:

"Clearance over Roof—Conductors shall have a clearance of not less than 8 ft from the highest point of roofs over which they pass, except where the voltage between conductors does not exceed 300 and the roof cannot be readily walked upon, the clearance may be not less than 3 ft."

This being a flat roof, it can be readily walked upon, and the 8-ft clearance pertains to roofs over which they pass. In the latest edition of the National Electrical Code Handbook by Abbott and Stetka, the note or explanation concerning this section clarifies your question, and I am in agreement with the explanation, which is as follows:

"In Section 230-24a, the phrase 'roof cannot be readily walked upon' is generally understood to mean a flat roof or a roof with not more than a 15- or 20-degree grade. As the roof grade increases, it becomes more difficult to walk upon without sliding or slipping, and normally, only building-repair or maintenance workers would have reason to be on such roof.

"In the case of overhead service conductors attached to a point on the roof when coming from a pole, the above is not to be construed as forbidding the point of attachment to be less than 3 ft; i.e., some ranch-type or low-roofed buildings may require the use of a telescope-type service which extends through the roof to assure minimum clearances above grade level. In such cases, it is sometimes necessary for overhead conductors to be slanted downward from a distribution pole at such points of attachment less than 3 ft.

"The main intent of Section 230-24 is to provide the clearance specified and to prevent mechanical damage and accidental contact of service conductors."

Your question concerns a school building, and as an extra precaution I would certainly recommend that the connections between the service drop and the service wires emerging from the conduit be well insulated with a weatherproof plastic type tape.—R.E.W.—5/61/6

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In the News

First IES Spring Conference Held

The Illuminating Engineering Society launched its series of nine spring regional meetings with the East Central Regional Conference in Philadelphia on April 10-11. The series will conclude with the Great Lakes Regional Conference in Cincinnati, Ohio, June 19-20.

Nearly 200 IES members and guests registered for the two-day conference in Philadelphia, which embraced five technical sessions, an Applied Lighting Competition runoff, a President's Luncheon, two receptions, and a dinner-dance. The technical sessions included eight technical papers, and a symposium presented by a four-man panel of experts.

At the opening session, Carman D. Miller, vice president of the IES East Central Region extended regional greetings, and introduced Milton I. Allen, vice president, Sales, Philadelphia Electric Co., who welcomed the conference group to Philadelphia. In his brief talk, Mr. Allen pointed out that lighting application is being promoted by several groups—Better Light Better Sight Bureau, National Electrical Contractors Association, National Electrical Manufacturers Association, Industrial Electrical Council, and Edison Electric Institute, to name a few—and urged the IES to assume greater leadership. One way to do this, for example, is to interpret research and relate it to final application, he said.

The first technical session was chairmanned by Kenneth W. Cobb, chairman of the IES Capital Section, Washington, D. C., and consisted of three papers.

First speaker on this session was Robert T. Dorsey, General Electric Co., Nela Park, Cleveland, who discussed "The Latest in Light Sources and Their Application." This was primarily a slide presentation. Included in this presentation was a comparison of growth of lamp sales with other growth rates, from 1948 to 1960. Shown was: U. S. population—1.73% per year; lamps consumed—2.83% per year; kwhr consumption by lamps—5.9% per year; and use of light (lumen hours)—9.3% per year.

John J. Neidhart, Miller Co., Meriden, Conn., discussed "A Logical Approach to the Commercial Lighting Problem," and presented over-all data for lighting levels of 50, 100 and 200 footcandles using 40-watt RS lamps, 800-ma high-output lamps, and 1500-ma extra-high-output lamps. These data were prepared for several types of luminaires. While conclusions are dangerous, due to variations in data with different types of luminaires, the results indicated generally that economies result from the use of the higher-ampere loaded lamps.

NEW CHAIRMAN of the Illinois Chapter, IAEI, is Wm. P. Hogan, Jr., chief electrical inspector, City of Chicago. Mr. Hogan is also current president of the Western Section, IAEI.

Industry generally has accepted the new IES light levels for production areas, ranging from 100 footcandles up, for most visual tasks, according to George W. Clark, Sylvania Electric Products Inc., Wheeling, W. Va., who discussed "High Intensity Industrial Lighting." Many examples of comfortable high-level ligthing in production areas were shown by slides, and the need for better visual environments was stressed.

The second technical session, chairmanned by James B. Nall, chairman of Pittsburgh Section IES, was a symposium on "Integration of Lighting, Heating and Air Conditioning," which was moderated by Robert T. Dorsey, General Electric Co., Cleveland. The panel for this symposium consisted of Murray L. Quinn, Day-Brite Lighting, Inc., St. Louis; Walter W. Kennedy, Barber Colman Co., Rockford, Ill.; Paul H. Yeomans, Consulting Engineer, Philadelphia, Pa.; and Herbert H. Swinburne, Nolan & Swinburne, Philadelphia, Pa.; representing a lighting equipment manufacturer, an air conditioning equipment manufacturer, a consulting engineer, and an architect, respectively. Each panelist discussed the symposium subject from his own viewpoint of interest, and illustrated his points by means of slides. A question and answer period followed, and much interest in this subject was demonstrated by the delegates.

The third technical session, chairmanned by William F. Speed, chairman, Philadelphia Section IES, was devoted entirely to the IES Applied Lighting Competition runoff of winners at the regional level.

In the Classification I—Residential group, First Prize award was made to Elizabeth A. Meehan, Philadelphia Electric Co., Philadelphia, for her entry titled "Light, Liberty and the Pursuit of Happiness." This covered the lighting in a suburban Philadelphia home.

In Classification II—Commercial/Industrial, the First Prize award went to Albert A. Fox, Washington, D. C., for his entry "Lighting a Liturgical Church-In-The-Round." Second Prize award to G. Earle Watt, Philadelphia Electric Co., Philadelphia, for his entry "Lighting With Dignity," for the Rowland Funeral Home, Abington, Pa. The Third Prize award was made to John B. Jaecklein, Baltimore, Md., for his entry "Relighting of Mens' and Boys' Dept." in Hutzler's Downtown Dept. Store, Baltimore.

The fourth technical session was devoted to floodlighting and store lighting, and was chairmanned by Luther S. Reams, chairman of Virginia Section of IES.

William P. Graham of Philadelphia Electric Co., gave a slide-illustrated talk on "See the Unseen Architecturally," which related to the floodlighting of monumental-type buildings, in Europe and the United States.

A paper on "Floodlighting Makes the Difference" was read for Robert H. Goodman, Crouse-Hinds Co., who was unable to attend the conference. It covered the types of floodlights and beam patterns that are available for incandescent and mercury lamps for the various floodlighting applications encountered.

David W. Loucks of Duquesne Light Company gave a most interesting slide-illustrated talk on "If I Had a Store —," in which he featured "lighting benefits" in laymen's language, and urged lighting engineers to get away from their technical lingo and talk the customers' language.

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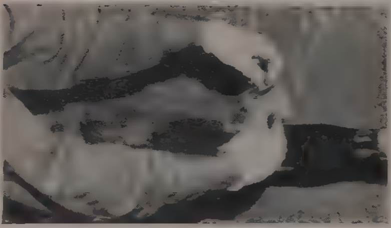

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BACK TO SCHOOL, notebooks and all, at University of Wisconsin two-day seminar on estimating for electrical contractors come [illegible] R. Guse, Guse Electric Co., Elgin, Minn.; and John N. Ellenbecker, Granite City Electric Co., St. Cloud, Minn.

The fifth and final technical session included the presentation of two papers only—one technical, and the other general.

R. N. Edwards of Westinghouse Electric Corp., Cleveland, discussed "This Factor Called Maintenance," in which the individual components of lighting maintenance factors, as they apply in interior lighting design to the minimum maintained-in-service lighting levels was covered in detail. Mr. Edwards challenged IES to develop a standard recommended practice for determining minimum maintenance factors, to remove the confusion and variations in practice which now exist.

The concluding paper for technical sessions covered "Lighting Trends During the Sixties," which was presented by Berlon C. Cooper, associate editor, *Electrical Construction and Maintenance.* The outlook for new building construction and modernization during the decade of the Sixties, backbone for lighting markets, was given, and factors which influence lighting system design and lighting equipment trends were discussed. Based on a sound and growing national economy, and a political climate favorable to private enterprise and initiative, all factors are favorable for a true renaissance in lighting, and expanding lighting technology, Mr. Cooper stated.

A highlight of the conference was the President's Luncheon, and an address by IES President Richard G. Slauer. President Slauer reported briefly on the Society and its activities, and the place of IES in the lighting industry's growth. IES is the image of a profession, the alter ego of an industry, he commented. He urged IES to broaden its scope, to earn and to show more leadership, and to make greater use of the Blackwell (Dr. H. R. Blackwell) data.

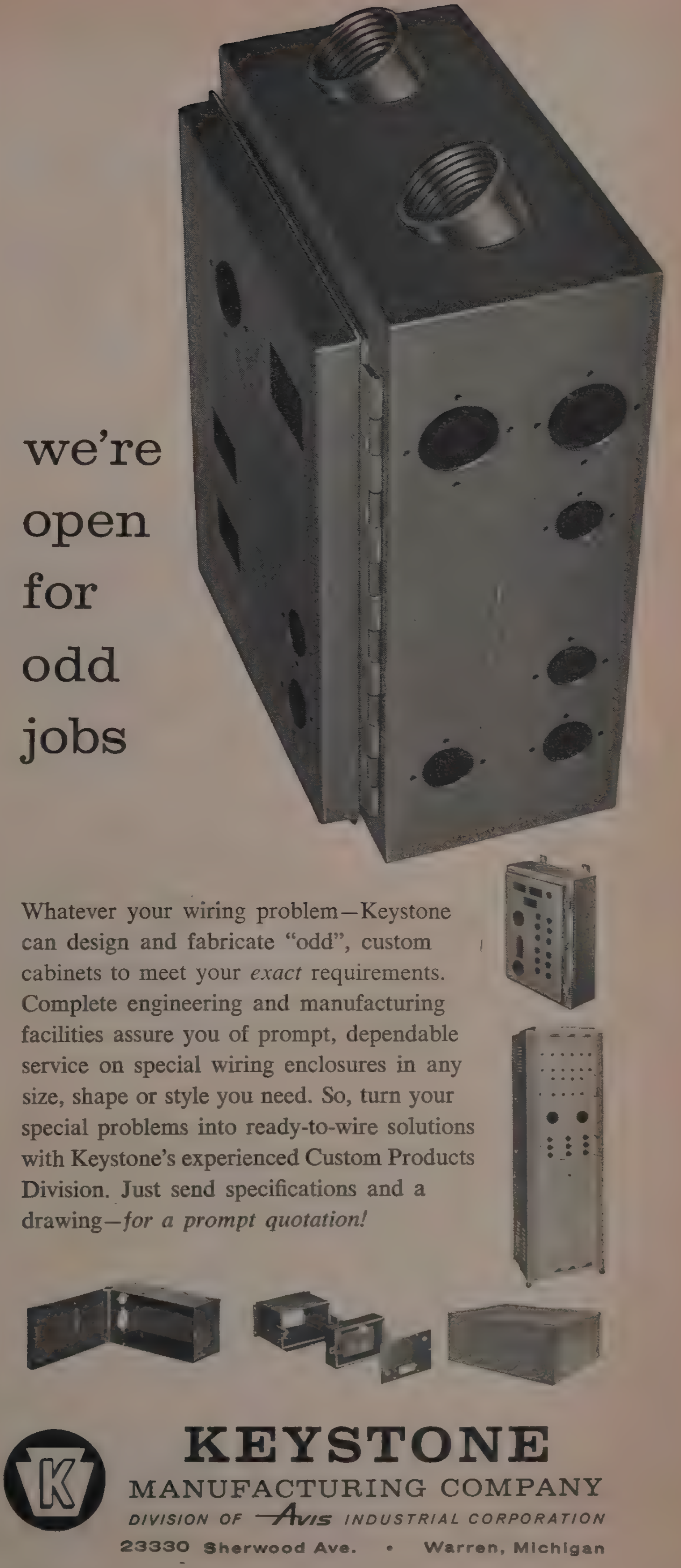
EMEA Conference Held in Los Angeles

The seventh bi-annual conference in a series sponsored by the Electrical Maintenance Engineers Association of California was held at USC, Los Angeles, March 28-30, with approximately 300 plant engineering, maintenance and management delegates attending this 3-day meeting. Featured on the program were five panel discussions pertaining to codes; electronic maintenance; management-maintenance cooperation; industrial maintenance procedures and personnel relations; while additional dinner and luncheon speakers, a concurrent exhibition of electrical products, plus a group visitation to a large automotive assembly plant rounded out an unusually practical, informative conclave.

Keynoting the general theme of the meeting, George E. Kinney, Jr., of Hughes Aircraft, discussed The Changing Face of Maintenance caused by an increasing emphasis on automatic, integrated operation of equipment; corresponding high costs of production; demands for continuity of essential power and the vital role assigned to maintenance to insure this continuity. To illustrate, he discussed numerical control of equipment; that is, feeding coded information from magnetic or punched tapes or cards into digital devices that translate data into machine action, thereby moving tools from one point to another automatically, such as for spindle drill operations, or moving tools along continuous paths, such as for cutting.

This is not "automation" as we generally think of it, Kinney said,

LIGHTING FIXTURE and equipment display at the Upper Midwest Electrical Industry Convention in Minneapolis is examined by (l to r) Albert Birkeland, Birkeland Electric, Merrifield, Minn.; J. M. Brindley, W. A. Roosevelt Co., LaCrosse, Wis.; and Lloyd Brown, Brown Electric Co., Decorah, Iowa.



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ATTENDING the EASA Southwestern Chapter meeting in Lubbock, Texas, were (L-R): Cecil T. Cline, Essex Wire Corp., Fort Worth, Texas; Homer D. Russell, R&E Electric Co., Kilgore, Texas; Connie Henry, Motor Rewinding Co., Dallas, Texas; C. G. Smith, Smith-Milligan Electric Co., Tulsa, Okla.; and Richard Hoorebeke, Complete-Reading Electric Co., Chicago.

since that term generally applies to large assembly plants such as those related to the automotive industry, whereas numerical controls being discussed could be advantageously utilized in smaller plants where operating essentials included accuracy, minimum feed and transfer times, high production, exact duplication and high over-all efficiencies. Downtime in such instances is critical, he continued, for when control is interrelated to hydraulics and mechanics as well as to electronics, the cessation of numerical control would idle an entire plant. For this reason maintenance must be preventive, with personnel trained for exacting work.

As one of five conference panel discussions, a session on codes presented viewpoints of City and State inspectors as well as underwriters and utilities, since the panel, moderated by Sidney F. Hill, president of Hill Electric, included G. A. Wintz, electrical inspector for the City of Los Angeles; Merle A. Plummer, service requirements engineer for the Los Angeles Department of Water and Power; E. E. Carlton, supervising electrical safety engineer for the State of California; and Karl Geiges, vice president of Underwriters' Laboratories.

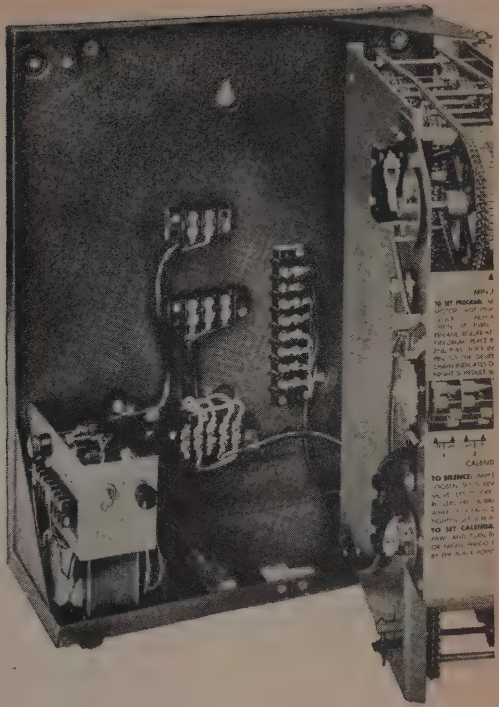
Remarks by G. A. Wintz advised contractors and plant maintenance men how to get along with inspectors. He stated that codes generally are compromises between economic limitations and public safety considerations and should be viewed as necessary minimum standards rather than as specifications for adequacy or maximum efficiency. He advised those present to study these codes, know their intended purpose, resist temptations to cut corners, and to respect the function, authority and responsibility of inspectors on the job.

Merle Plummer noted that codes promote essential "meeting of minds" between contractors, inspectors and engineers, often filling important gaps in job specifications. He likewise paid tribute to members of code-writing panels, stating that their jobs were meticulous and difficult because it was essential to phrase rules in language which would leave no doubts as to meaning.

Carlton pointed out that many variations still existed between certain national, state and local codes, and that unification of rulings would be most appropriate to avoid conflicts. Towards this end he cited California's Electrical Safety Orders, which had been established after holding series of open committee meetings wherein all interested persons could express their views on proposed recommendations. Then, after comments had been sifted and analyzed, standards were formalized and filed with all county clerks for further consideration for official local ordinances which subsequently could be enforced.

Karl Geiges stated that one objective of UL was to "protect an electrically untrained and uninformed public against inadvertent exposure to hazards." To do this, he said, the Laboratories inspect electrical items and equipment not only when they first appear on the market, but periodically thereafter to insure that initial characteris-

AT EASA MEETING in Lubbock, Texas, were (L-R): Marvin Cole, Insulation & wires, Inc., Houston, Texas; C. R. Hamilton, Hamilton Electric Works, Austin, Texas; Richard Hamilton, Reliance Electric & Engineering Corp., Dallas, Texas; J. B. Johnson, J&J Armature Works, Tyler, Texas; and Lester L. Luton, Luton Electric Service, Ada, Okla.



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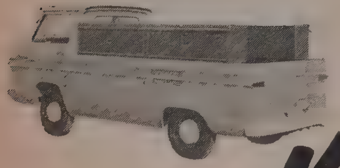

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AS AN AID to labor-management relations, J. E. Dow, executive vice president, Kelso-Burnett Electric Co., Chicago, tells contractors at recent University of Wisconsin seminar that K-B plans to develop and conduct a training course for their electrical foremen. Dow covered the labor-management subject at a 2-day meeting.

tics are maintained. He also discussed relationships between the NEC and UL, maintaining that some products approved by one were not always acceptable to the other, but although minor variances existed, the aims of the national code and UL standards were closely allied.

A second panel, discussing Electronic Maintenance, was moderated by Howard D. Lesher, senior electrical engineer for North American Aviation; panel participants including George A. Poate, electrician with Hearst Los Angeles newspapers; C. Leon Perry, supervisor of Engineering and Utilities, Columbia-Geneva Division of U.S. Steel; Gerald W. Anderson, electrical engineer for U.S. Rubber, and Wally Wingert, assistant supervisor of Electronics Training at North American Aviation. Collectively this panel discussed trouble-shooting procedures, planned maintenance scheduling and supervision, electronic drives, selection and training of qualified personnel.

This round-up of related subjects included comments pertaining to variable temperatures and ventilation affecting operations of sensitive control components; the need for understanding and cooperation between maintenance, management and operation men; the effect of dust on microswitches and relays; and deleterious effects of vibration or stray light on photocells. Also there was considerable emphasis upon the importance of production continuity today "regardless of cost" of maintenance; the use of oscilloscopes for detecting trouble within electronic circuits; the necessity for keeping detailed records; inventory scope; maintenance scheduling, and various recommended procedures for inspection, estimating and follow-up of repairs.

Promotion of a productive attitude between management and maintenance departments was the subject of a panel consisting of Lou Strauss of Sunkist Growers; Regis Gubser, vice president in charge of engineering for California Consumers; Floyd O. Nelson, electrical department head for Alcoa's Rome Cable division, and Donald K. Higgins, special project engineer for American Potash & Chemical. Moderated by Bernard A. Shrive, electrical superintendent for Kaiser Steel's Fontana plant, this panel analyzed management objectives, ways and means of implementing them, planned incentives for workers and the integration of men and methods.

Strauss maintained that maintenance is an economic function, and that progressive companies will not hestitate to invest in maintenance, good tools and equipment, training programs and comprehensive inventories, provided it can be proved that these investments will result in producing quality products that can be sold at a profit and thereby return dividends to stockholders. Management expects maintenance to have foresight, plan ahead, make accurate predictions of upcoming major expenses and order inventory stock with intelligence. And, since management is not expected to know all the answers concerning codes and recommended safety procedures, it also is the maintenance superintendent's responsibil-

CHAIRMAN EMERITUS of Illinois Chapter, IAEI, program committee is honor bestowed on S. R. Todd (right) at recent annual meeting. Chapter immediate past-chairman L. E. Dunham, Springfield, congratulates Mr. Todd for his 31 years of consecutive chairmanship. Col. Todd, an active member of Chicago's electrical inspection department, has been past-president of the Western Section, past international president and a member of IAEI for some 41 years.

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HEADING UP new slate of officers of the Minnesota Electrical Assn., Inc., at the Upper Midwest Electrical Conference in Minneapolis were (l to r) Robert De War, De War Electric, Fairmont, Minn., vice president, and Stan Berquist, Berquist Electric, Litchfield, Minn., president.

ity to assume this advisory function, he concluded.

Gubser cited three objectives which should be considered: (1) reliability of equipment, (2) minimum interruptions of production schedules, and (3) minimum over-all costs for service. These could be obtained only by analyzing equipment and problems, he said; noting nameplate data; determining to what extent equipment effects production; assigning a priority commensurate with a machine's importance; compiling records to determine the necessity and effectiveness of periodic inspections and repair work, and advising management of approaching overloads caused by increasing production or changes in operating practices. To obtain minimum over-all maintenance costs, he continued, it is sometimes cheaper to replace a motor rather than repair it, and "outside" contractors frequently can perform given assignments faster and cheaper than can plant crews, so these alternatives should be seriously considered.

Nelson contended that maintenance supervisors generally understand equipment problems, the function of tools and the operation of machines, but they do not always understand the philosophy of human relations. He also discussed methods for encouraging men in skills of endeavor, mentioning that planned incentive systems can overcome apathy, spur application and improve attitudes. Such systems, however, have to be consistent and honest, requiring recognition of abilities, the establishment of practical work standards, a fair assignment of objectives and an attainable basis for bonuses.

Higgins, who is responsible for a

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plant having many buildings scattered over a wide geographical area, stated that nearly 50% of all employees in this vast concept were related to maintenance work in some form, and that intelligent maintenance would be impossible without accurate records, history cards, machine identification, work orders, inventory replacement, cost data and management-maintenance meetings to coordinate mutual understanding of operation objectives and maintenance requisites.

Industrial Plant Maintenance, the subject for the fourth panel discussion, was ably considered by Bob Marcum, manager of plant services for Hughes Aircraft; Frank S. Miller, plant engineer for Robertshaw-Fulton Controls' Grayson division; Dr. Henry L. Lee, Jr., technical director for the Epoxylite Corp.; and Dick Pehl, superintendent of mechanical maintenance for Kaiser Steel. This informative session was chairmanned by Frank G. Pierce, electrical engineer for Union Oil of California's Los Angeles refinery.

Marcum stated that most electrical maintenance problems pertained to main switchgear, breakers, transformers, feeders, fuses, panelboards, branch circuits and motors. Then, by discussing numerous case studies, he commented upon specific troubles, their causes and corrections; suggesting numerous ways to inspect and repair equipment, insure safety of men and equipment, anticipate and schedule major shut-downs.

Frank Miller advocated orderly pre-planning; citing, as examples, scheduled inspections, group lamp

ATTENDING a recent meeting of the EASA Southwestern Chapter in Lubbock, Texas, were (L-R): Ken Bell, Electrical Supply, Dallas, Texas; Allan Shipman, Butts Electric Supply Co., Oklahoma City, Okla.; C. W. Davall, John C. Dolph Co., Monmouth Junction, N. J.; Fred Fehrenkamp, Houston Industrial Supply Co., Houston, Texas; and William Weirich, Lenni Products, Lenni Mills, Pa.

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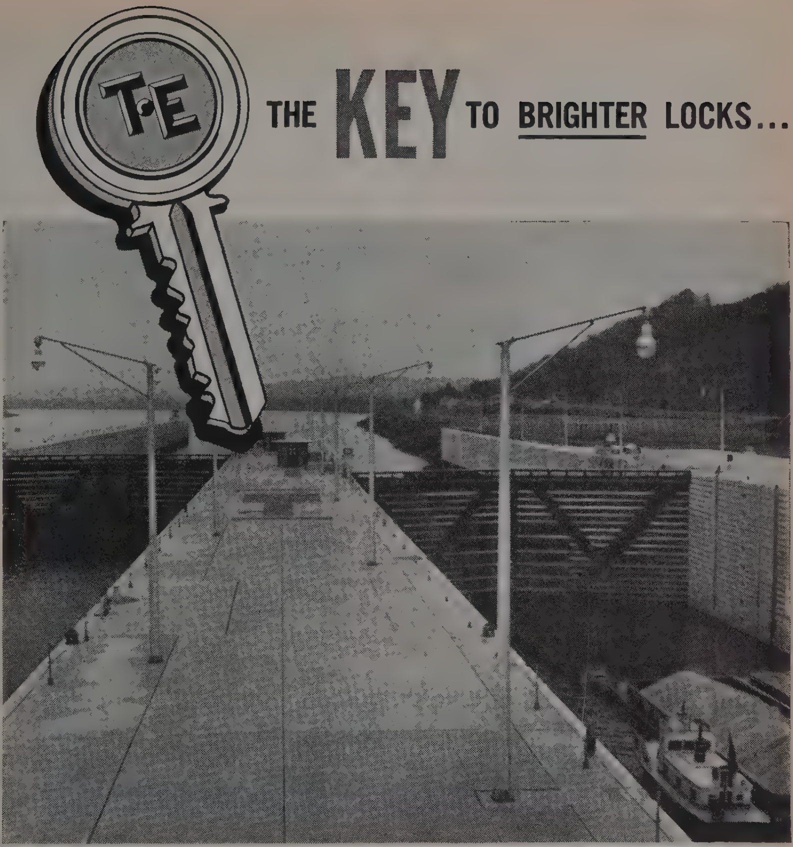

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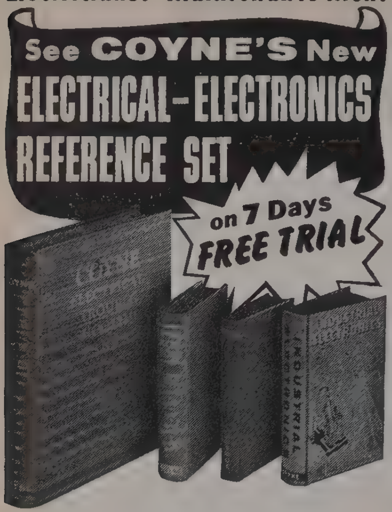

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PARTICIPATING in 24th Annual Upper Midwest Convention in Minneapolis were (l to r) Merton Jacobson, North Dakota State School of Science, Wahpeton, N. D.; T. J. Hickman, Northern States Power Co., St. Paul, Minn.; and A. A. Aronson, Northern States Power Co., Minneapolis, Minn.

replacement and the deduction of "reliability factors" pertaining to such equipment as timers, relays and contactors, where the number of cycling operations could be recorded accurately in order to predict normal life expectancies without failure.

Dr. Lee's discussion on epoxy resins included an interesting review of progress in insulations and motors; slides and displays illustrating past improvements in motor costs and core losses, present methods for encapsulating motors and transformers, and coming trends in motor construction using corrugated molds, which can be adjusted for height and diameter to contain coils of different numbers and sizes to obtain desired horsepower ratings and characteristics.

Pehl's contribution concerned spare parts as adjuncts to maintenance. He stated that parts should be proportional to numbers and importance of machines of that size or type, and that equipment should be re-evaluated frequently to determine whether it should be reconditioned, replaced by better products, or dropped from inventory because of lack of demand.

The fifth conference forum was an interesting innovation in maintenance programs, for it concerned the necessity of getting along with others to achieve maximum personal benefits in today's economy. This session prompted enthusiastic audience response; skillfully promoted by the two speakers who reversed the usual question-answer approach by tossing questions at the *audience* instead of answering comments or queries from delegates. These two speakers were

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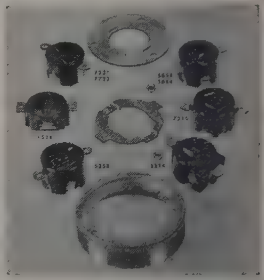

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Erwin G. Wallenbrock, manpower development manager for Don Baxter, Inc., and Norman E. Watts, west coast manager for Florez, Inc.

Those responsible for this EMEA conference included co-chairmen Robert R. Proctor, Larson-Hogue Electric, and John Horsburgh, Kaiser Steel; program chairman Charles M. Tabor, Larson-Hogue; Walter J. Collins, L. A. Dept. of Water & Power, registration; Paul H. Henrichs, So. Calif. Edison, exhibits; Richard W. Fletcher, Fletcher Electrical Specialty Co., banquet; Lloyd A. Gates, L. A. Dept. of Water & Power, arrangements; Richard B. Hatfield, So. Calif. Edison, field trip; Fletcher and Hatfield, luncheon speakers; and William R. Paluska of Albert C. Martin & Associates, finances.

Other behind-the-scene workers included Oswald D. Land, industrial engineer, president of EMEA; Urban Beh, consulting lighting engineer, first v. p.; plus K. Lee Alvey, Airesearch Mfg. Co.; King D. Christopher, The Clark Controller Co.; Norman E. Stone of the Traffic Appliance Corp.; Ernest A. Burgess and William A. Rinehart.

EASA News

Ronald P. Clark, Phelps-Dodge Products Co., spoke to the Chicago chapter at its March 14 meeting on the effects of insulations and coatings on magnet wire.

Regional director Joseph F. Ferrari, Sr., outlined some of the interesting features of the forthcoming San Francisco convention program.

Members Bill Luebker, Glenn Glave and Bob Ferrari reported on the recent management seminar for the benefit of those who did not attend it.

• • • •

The Midwestern chapter held its spring meeting at the Hotel Castle, in Omaha, Neb., on April 8. High point of the meeting was a talk on "How to Merchandise Your Services More Effectively," given by Dr. Jack S. Wolf, associate professor of marketing at St. Louis University. Thomas M. Paul, of Sioux City, Iowa, area national director, also attended.

• • • •

On May 5 and 6, the Heart of America chapter will hold its meeting at the Town House Motor Hotel, in Wichita, Kan. Entertainment will include a tour of the Beech Aircraft plant, a dance at the Town Club, and the annual

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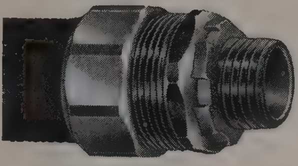

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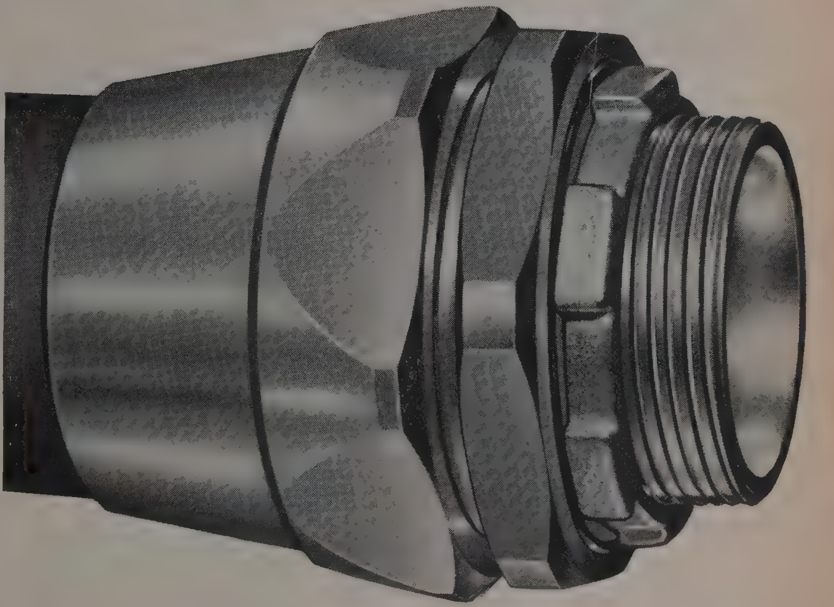

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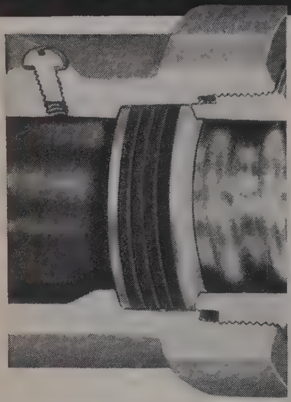

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"hospitality hour." A variety of speakers have been engaged, among them EASA Executive Vice-President Joseph M. Harrington and National President J. Arthur Turner, Jr.

• • • •

New officers of the Niagara (upper New York State) chapter are: George Novas, Square Electric Co., Syracuse, president; Chester Tanner, Industrial Motor Service, North Tonawanda, vice president; LaVerne Lester, Nypenn Electric, Dunkirk, secretary; and John Grzebinski, Allied Electric, Tonawanda, treasurer.

National Treasurer Al Shovan spoke on the national seminars at the February 24 meeting, held in Rochester at the Sheraton Hotel.

• • • •

Prof. L. M. Walker gave the concluding lecture in his series to the Puget Sound chapter at its March 7 meeting at Andy's Diner in Seattle, Wash. "Profit Management" was the subject of his talk.

• • • •

Rocky Mountain chapter held a two-day spring meeting at the Heart O' Denver Hotel, Denver, Colo., on April 7-8. Technical information was emphasized in the program. There was a special program for women guests.

• • • •

St. Louis members saw a special demonstration of the new Klixon motor protector at a short meeting held at the Mechanical Supply Co. on March 22. R. M. Parker, Texas Instruments, gave demonstration.

A technical forum was held in Savannah, Ga., on March 24-25 by the Southeastern chapter. In addition to a variety of technical information, there was a tour of local

A SHOP TOUR at W. M. Smith Co., Lubbock, Texas, was enjoyed by C. R. Davis, Phelps Dodge Copper Products, Dallas, Texas; Earl Summers, Summers Electric Co., Dallas, Texas; R. M. Howe, Phelps Dodge, Fort Wayne, Ind.; and D. P. Miller, B&M Machinery Co., El Paso, Texas.

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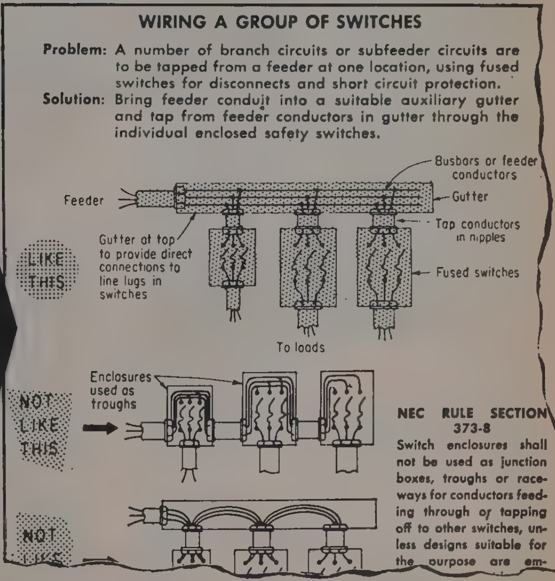

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Gutter at top to provide direct connections to line lugs in switches
Busbars or feeder conductors
Gutter
Tap conductors in nipples
Fused switches
To loads
NOT LIKE THIS
Enclosures used as troughs
NOT

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- Motors and Controllers
- Conductors
- Raceways
- Switches
- Overcurrent Protective Devices
- Switchboards and Panelboards
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J. ARTHUR TURNER, JR. and Mrs. Turner, of Tampa (Florida) Armature Works, enjoy an unexpected spring snow during a tour of Plymouth Rock, Plymouth, Mass., en route from a meeting of the New England Chapter of EASA. It was the first snow the Turners had seen since childhood. Mr. Turner is national EASA president.

shops, an open forum and a work session.

• • • •

On May 19, members of the Quaker City chapter will gather at the Sandy Run Country Club for their annual social get-together.

EASA National President J. Arthur Turner, Jr. was a guest at a meeting on March 15, at Beck's Restaurant in Philadelphia.

• • • •

Wisconsin chapter members met at Racine, Wis., on March 21 for a business meeting. Before the meeting they toured the Johnson Wax Plant and offices, and the Industrial Motor Service. Ed Guttenberg, of Johnson Wax's research and development section, spoke to the members on marketing trends and the analysis of sample marketing.

The May meeting will be in the offices of the Helwig Co., Milwaukee, Wis.

• • • •

New officers of the New York Metropolitan chapter were installed at the March 16 meeting by National President J. Arthur Turner, Jr. This meeting was also the second annual "Father and Son" night.

A management seminar program will be held in New York City at the Hotel Statler on May 25, 26, and 27.

• • • •

New England members met at the Hotel Bradford, in Boston, Mass., on February 9 for the regular business meeting and a talk by Daniel McKay on the causes and control of fires.

The annual Foreman's day meeting was held on March 18, at the Hotel Bradford, in Boston.

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DATES AHEAD

Illuminating Engineering Society—Regional Conferences; **Canadian**, Queen Elizabeth Hotel, Montreal, Que., May 15-16; **Northeastern**, Berkeley-Carteret Hotel, Asbury Park, N. J., June 8-9; **Great Lakes**, Sheraton-Gibson Hotel, Cincinnati, Ohio, June 19-20.

National Fire Protection Association—Annual convention Hotel Statler, Detroit, Mich., May 15-19.

Building Research Institute—Spring Conference, Shoreham Hotel, Washington, D. C., May 16-18.

Edison Electric Institute—Annual convention, Waldorf-Astoria Hotel, New York, N. Y., June 5-7.

Electrical Apparatus Service Association, Inc.—28th annual convention, Jack Tar Hotel, San Francisco, Calif., June 11-14.

International Association of Electrical Inspectors — Chapter Meetings — **Virginia**, Hotel Roanoke, Roanoke, Va., June 12-13; **Northwestern Section**, Owyhee Hotel, Boise, Idaho, September 11-13; **Southwestern Section**, Hotel Del Coronado, Coronado, Calif., September 18-21; **Western Section**, Biltmore Hotel, Oklahoma City, Okla., September 25-27.

New York State Association of Electrical Contractors & Dealers—62nd annual convention, Whiteface Inn, Lake Placid, N. Y., July 2-7.

Western Plant Maintenance Show—Pan American Auditorium, Los Angeles, Calif., July 18-20.

National Assn. of Lighting Maintenance Contractors—National conference, Las Vegas, Nev., August 21-23.

Western Electronic Show and Convention—Cow Palace, San Francisco, Calif., August 22-25.

American Home Lighting Fixture Month—Sponsored by the American Home Lighting Institute, Chicago, Ill., September 1-30.

Rocky Mountain Electrical League—Fall Convention, Jackson Lake Lodge, Moran, Wyoming, September 10-13.

Illuminating Engineering Society—National Technical Conference, Chase Park Plaza Hotel, St. Louis, Mo., September 24-29.

Third Virginia Biennial State-Wide Industrial Exposition—Victory Stadium, Roanoke, Va., September 27-30.

International Association of Electrical Leagues—25th Annual Conference, President Hotel, Atlantic City, N. J., October 4-6.

Western Building Industries Exposition—Great Western Exhibit Center, Los Angeles, Calif., October 7-10.

17th Annual National Electronics Conference — International Amphitheatre, Chicago, Ill., October 9-11.

National Electrical Contractors Association—Annual convention, Washington, D. C., October 9-14.

National Electrical Manufacturers Assn.—Annual meeting Traymore Hotel, Atlantic City, N. J., November 13-17.

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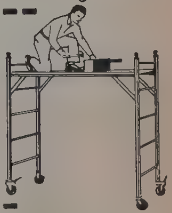
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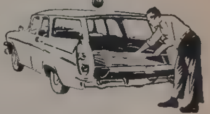
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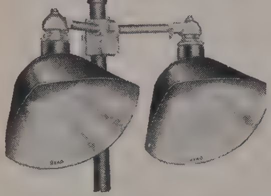

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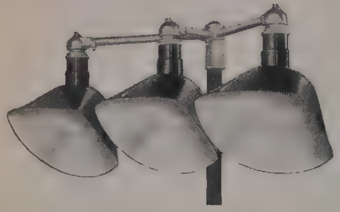

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Fairbanks, Morse & Co., Chicago, Ill.—Arthur Sternberg, vice president and general manager, Electrical Div., Freeport, Ill.

Clayton Mark & Co., Evanston, Ill.—James B. Carse, general sales manager.

Union Switch & Signal, Div. of Westinghouse Air Brake Co., Swissvale, Pa.—Ted C. Schroeder, manager, Industrial Projects.

General Electric Co., Bridgeport, Conn.—David A. Pritchard, manager of sales, Wire and Cable.

General Electric Co., Schenectady, N. Y.—Peter C. Van Dyck, general manager, Service Shops Dept.; Forrest H. Judkins, manager of manufacturing, Insulator Dept., Baltimore, Md.; Dan C. Kyker, manager of materials, Outdoor Lighting Dept., Hendersonville, N. C.

Sylvania Electric Products Inc., New York, N. Y.—Eugene E. Broker, general manufacturing manager, Parts Div., Warren, Pa.

Radiant Lamp Corp., Newark, N. J.—Harold A. Erickson, sales manager.

Day-Brite Lighting, Inc., St. Louis, Mo.—William C. Nusbaum, vice president.

Kennecott Copper Corp., New York, N. Y.—Edward L. Steiniger and Albert Green, board of directors.

Oak Manufacturing Co., Crystal Lake, Ill.—William S. Strout, vice president of purchasing.

Edwin F. Guth Co., St. Louis, Mo.—Russell R. Viehman, vice president; Kurt Kleindienst, advertising manager.

Sequoia Wire and Cable Corp., Redwood City, Calif.—Eugene A. Christian, Jr., chief engineer.

Royal Electric Mfg. Co., Inc., Chicago, Ill.—James H. Hilton, director of marketing.

Black & Decker Mfg. Co., Towson, Md.—Robert C. Tyo, vice president, DeWalt operations.

Shallcross Mfg. Co., Selma, N. C.—John E. Lillich, vice president of manufacturing; Clement W. Sharek, vice president of engineering.

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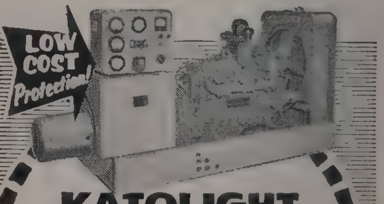

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Hyster Co., Portland, Ore.—Glenn Herz, vice president of engineering; James L. Woodley, vice president of manufacturing.

Westinghouse Electric Corp., Pittsburgh, Pa.—Charles W. Mills, manager of market development; John G. Aldworth, manager of electric utility sales department.

Elwell-Parker Electric Co., Cleveland, Ohio—Sheldon K. Towson, Jr., president and chief executive officer; W. A. Meddick, chairman of the board.

National Pneumatic Co., Inc., Boston, Mass.—Edward B. Selig, general sales manager of Janette Div., Holtzer-Cabot Div. and Telephone Div.

Gem Electric Mfg. Co., Inc., Brooklyn, N. Y.—Lou Pollan, sales manager.

Curtis AllBrite Lighting, Inc., Chicago, Ill.—Joseph R. Ray, vice president of sales; Irvin Wescott, director of marketing.

Dictograph Products Inc., Danbury, Conn.—Walter E. Froehlich, executive vice president.

Worthington Corp., Harrison, N. J.—William A. Finn, vice president, group executive; Paul R. Des Jardins, manager, engineering planning.

International Resistance Co., Philadelphia, Pa.—J. Penn Rutherfoord, executive vice president.

Penn Controls, Inc., Goshen, Ind.—J. F. Kinney, manager of electric heat sales.

Slater Electric and Mfg. Co., Glen Cove, N. Y.—Saul I. Slater, president; Francis J. Cashin, executive vice president; Herbert A. Slater, vice president; Thomas S. Slater, vice president; Melvin Schneider, secretary-treasurer.

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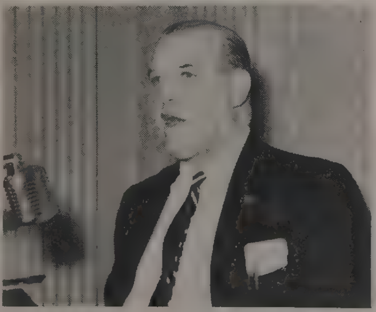

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Hubbard and Co., Chicago, Ill.—Thomas Hollingsworth, vice president of sales.

Esterline Angus Instrument Co., Inc., Speedway, Ind.—Hugh C. Cameron, sales manager.

Regional Appointments

NEW ENGLAND

General Electric Co.: Edward F. Coakley, sales representative for New England district, headquarters in Boston; Silicone Products Dept.

I-T-E Circuit Breaker.: Roland O. Farrar, Power Apparatus manager, Boston office.

MIDDLE ATLANTIC

Saginaw Products Corp.: R. J. Benson, New York district manager, headquarters in Hicksville, L. I., N. Y.

Accurate Manufacturing Co.: Barger & Martin, Inc., Pittsburgh, Pa., agents in Pittsburgh area.

The Gamewell Co.: John E. O'Malley, sales engineer in the upstate New York area, with offices in Geneva.

Union Carbide Plastics Co.: Lawrence J. Kelly, technical representative in the metropolitan New York region, with offices in Clifton, N. J.

Electro Lighting Corp.: Steward E. Robinson, vice president of eastern sales with offices in New York City.

Jay Lighting Mfg. Co.: Milton Thaler, sales manager for the New York area; Wallace Spanier, sales manager for eastern Pennsylvania, southern New Jersey, Delaware, Maryland and Washington, D. C., headquartered in Philadelphia.

Swivelier Co.: Goren/Newman, Inc., New York City, manufacturers representatives for metropolitan New York area.

SOUTH ATLANTIC

Union Carbide Plastics Co.: John B. Honish, technical representative in the South Atlantic sales region, located in Greensboro, N. C., district sales office.

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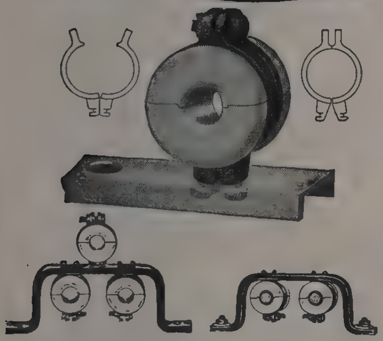

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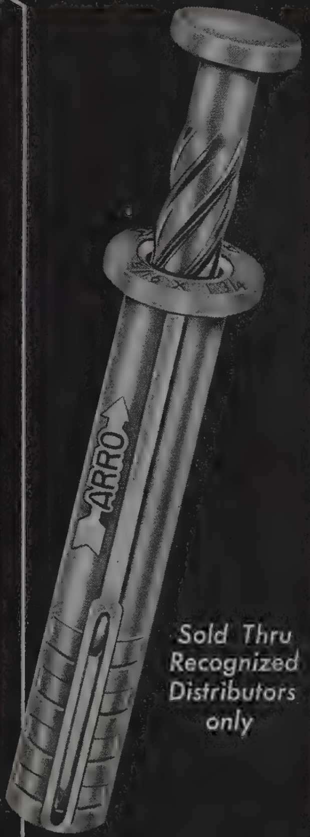

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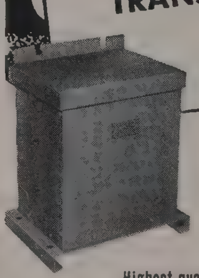

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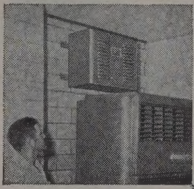

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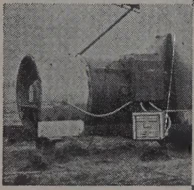

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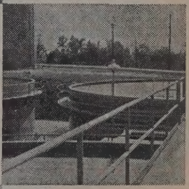

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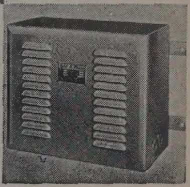

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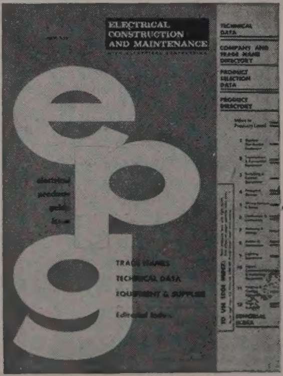

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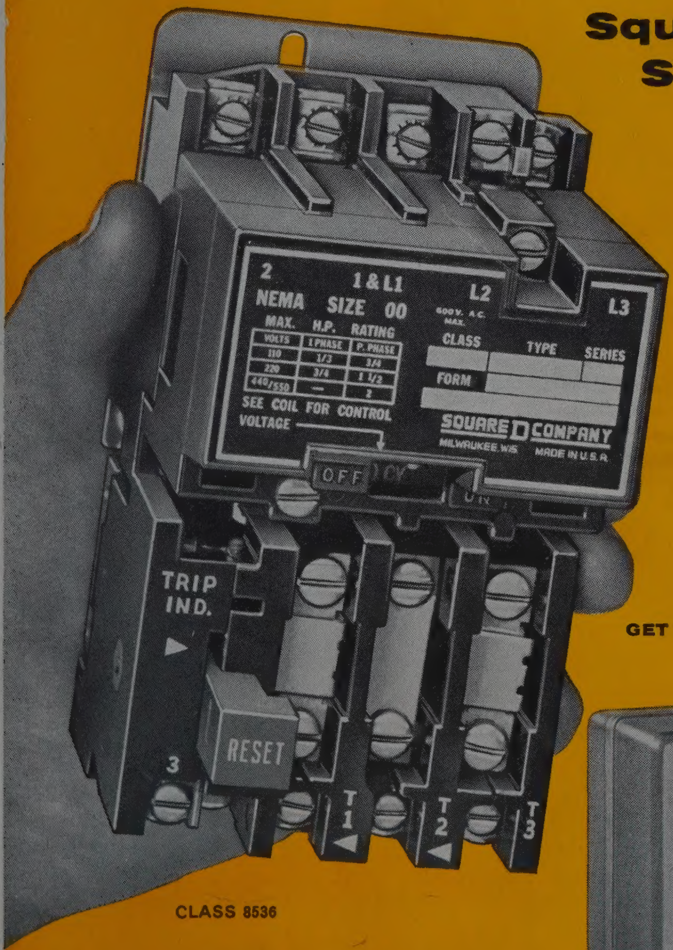

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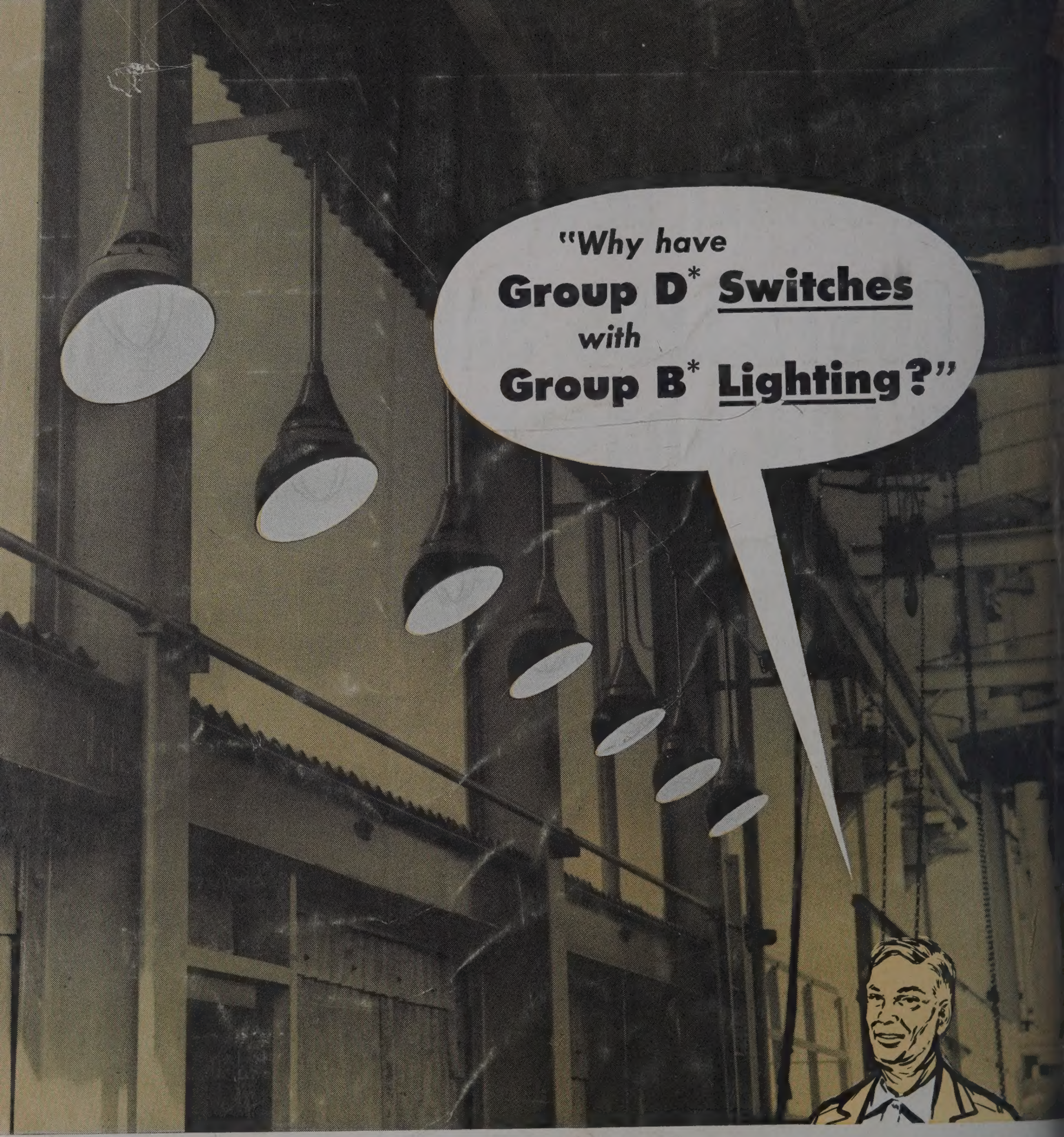

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